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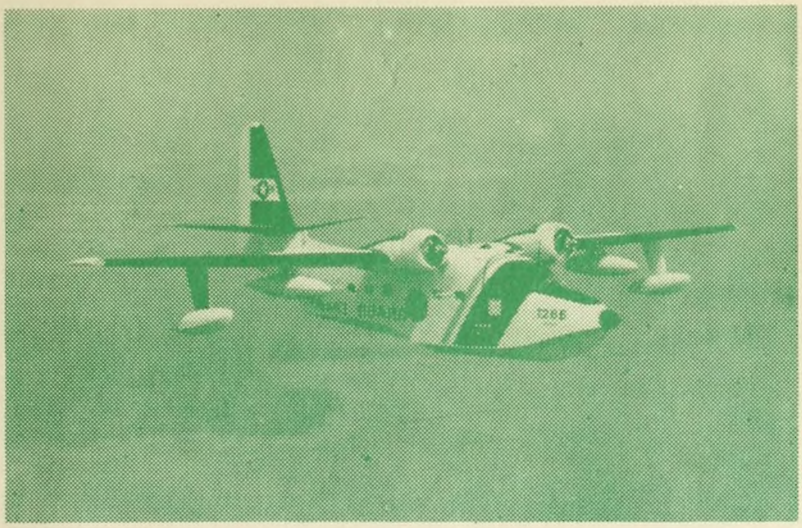
July 1970 - June 1976



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AIRBORNE RADIATION THERMOMETER MEASUREMENTS FROM CAPE COD, MASSACHUSETTS TO MIAMI, FLORIDA

July 1970 - June 1976

J. W. Deaver

J. C. Reed

United States Coast Guard
Oceanographic Unit
Washington, D.C.

December 1978

ABSTRACT

Sea surface temperatures (SST) for the period of July 1970 to June 1976 from Cape Cod, Massachusetts to Miami, Florida were measured during the U.S. Coast Guard Oceanographic Unit's Airborne Radiation Thermometer (ART) monthly surveys. A total of 72 monthly SST contoured isotherm charts are presented which are constructed from data obtained on these surveys.

The distribution of 9 species of marine animals as a function of latitude and SST are presented.

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AIRBORNE RADIATION THERMOMETER MEASUREMENTS FROM CAPE COD, MASSACHUSETTS TO MIAMI, FLORIDA

JULY 1970—June 1976

By

J.W. Deaver
J.C. Reed

INTRODUCTION

Since July 1969, the U.S. Coast Guard Oceanographic Unit has been conducting monthly Airborne Radiation Thermometer (ART) surveys of the United States Atlantic Ocean coastal waters between Miami, Florida and Cape Cod, Massachusetts. The primary purpose of these over flights was to measure sea surface temperature (SST) distributions and observe visual current boundaries connected with the Gulf Stream for use in Search and Rescue (SAR) planning. This information along with marine animal sightings and pollution incidents were published monthly under the title of "Surface Isotherm Charts" by the Coast Guard Oceanographic Unit.

This report covers the period July 1970 to June 1976. The data were collected using operating procedures previously published (Deaver, 1975). Over 564,400 km of transects covering approximately 1.08 x 10^7 km^2 of Atlantic Shelf and Slope Water and Gulf Stream were covered during the 7 years (Fig. 1).

From October 1974 to May 1975, no data were collected south of Cape Hatteras, North Carolina due to aircraft non-availability.

Surveys were normally scheduled for the middle of each month, however, surveys were sometimes delayed for periods of up to two weeks due to operational difficulties.

METHODS AND EQUIPMENT

A Barnes Engineering Company, Precision Radiation Thermometer (PRT-5) was used to measure the SST during ART surveys. The PRT-5 has been modified to view through the 9.5 to 11.5u wavelength window which was the most desirable filter available for SST measurements (Weiss, 1971). The PRT-5 signal was recorded on a continuous analog strip chart. The strip chart recorder was calibrated by measuring the known temperature of a hot and cold water bath prior to and at the completion of a flight.

An extensive review of the methods and equipment used was presented previously in Deaver, (1975).

SURFACE TRUTH ADJUSTMENT

All ART surveys were flown at or below 150 meters to avoid adverse atmospheric attenuation (Henderson, 1976). Data collected during periods of rain, snow, fog or heavy haze were discarded.

Accuracy of the ART data using selective sampling methods mentioned above is within ±0.6°C.

SEA SURFACE TEMPERATURE CHARTS

Monthly sea surface temperature charts for Atlantic Ocean coastal water from Cape Cod to Miami are presented in 72 charts (Figs. 2—73).

Contour charts were constructed utilizing temperature measurements along survey transects. Contour shapes between transect crossings were based on subjective interpretation and additional data from satellite and shipboard observations.

MARINE ANIMAL OBSERVATIONS

Sightings of nine types of marine animals observed on ART surveys have been recorded for the period July 1970 to June 1976 from Miami, Florida to Cape Cod, Massachusetts. These data are presented as a seven year weighted mean latitude and temperature value for each animal (Fig. 74). The formula utilized for this calculation was previously published (Deaver, 1975). These data are presented only as a by-product of ART surveys for the benefit of the oceanographic community.

ACKNOWLEDGEMENT

The authors are indebted to the pilots and crews of the Coast Guard aircraft involved in the monthly ART surveys and especially to the Marine Science Technicians at the Coast Guard Oceanographic Unit who obtained these data.

REFERENCES

Deaver, J.W. (1975) Aerial Oceanographic Observations, Cape Cod, Massachusetts to Miami, Florida, July 1969—June 1970. U.S. Coast Guard Oceanographic Unit Report No. CG 373-68.

Henderson, S.J. (1976) Low Altitude Infrared Sensing, U.S. Coast Guard Oceanographic Unit Technical Report 76-1.

Weiss, M. (1971) Airborne Measurements of Earth Surface Temperature (Ocean and Land) in the 10-12u and 8-14u Regions, Applied Optics, Volume 10 No. 62 p. 1283, June 1971.

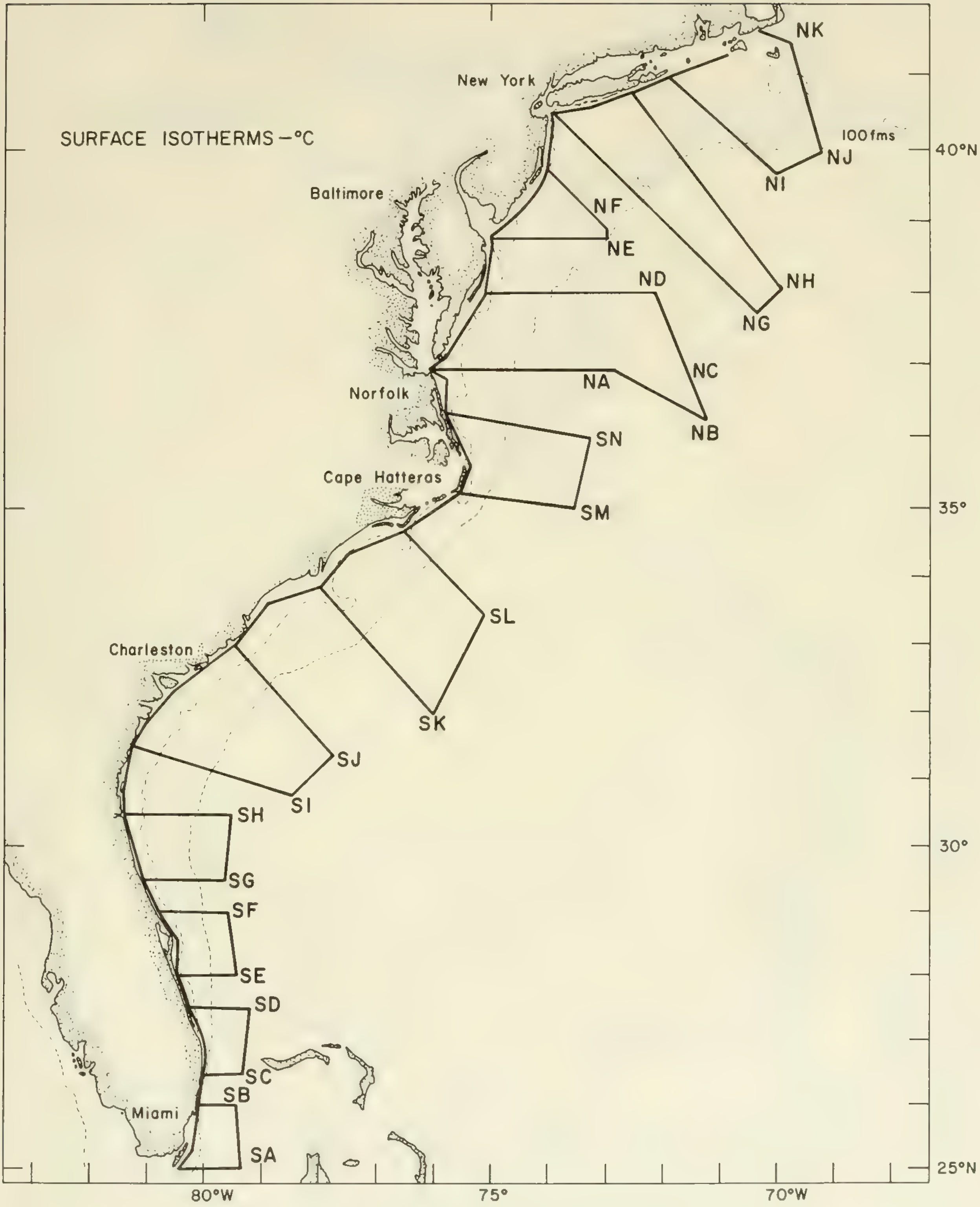
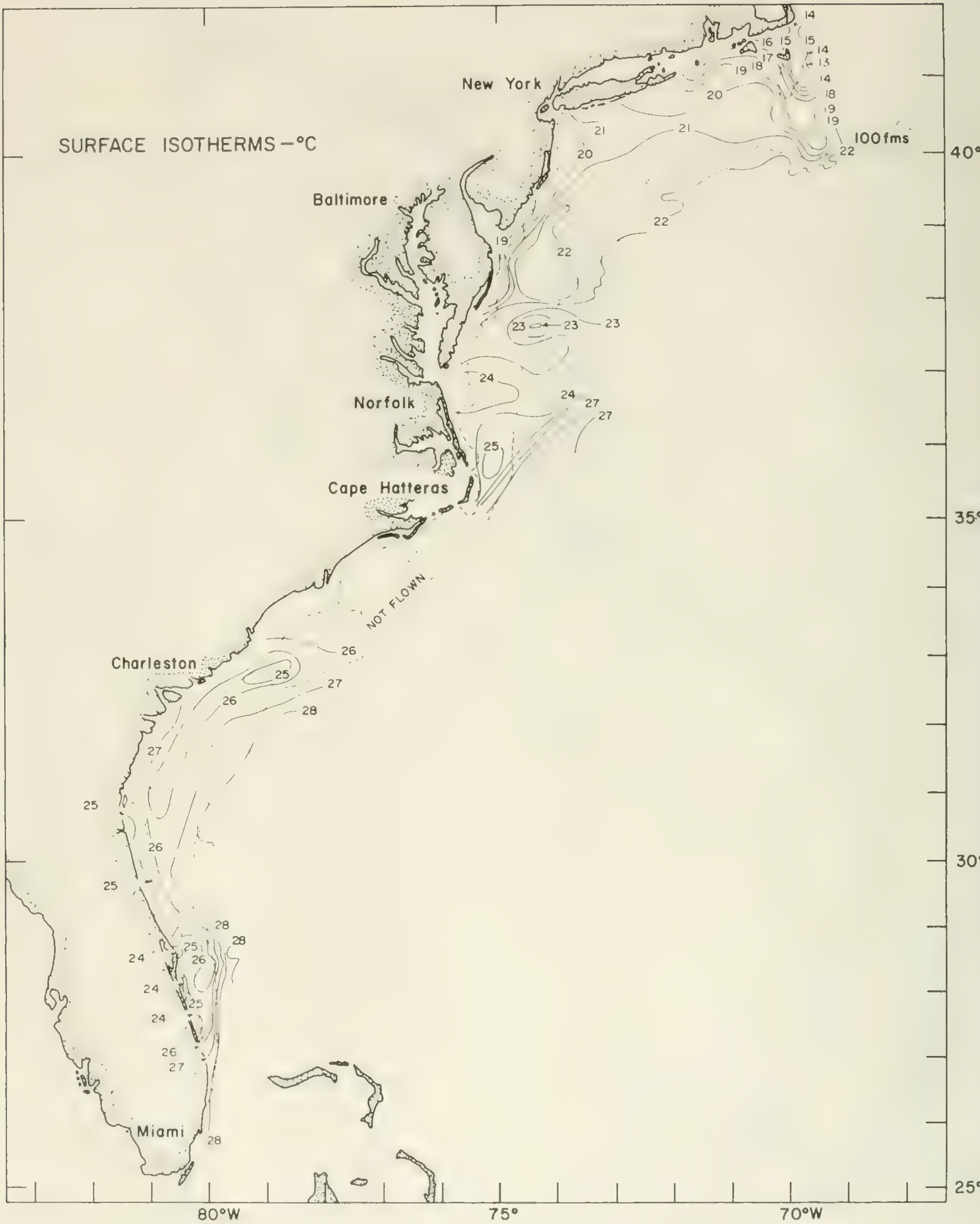


Figure 1. Standard ART flight trackline, July 1970–June 1976



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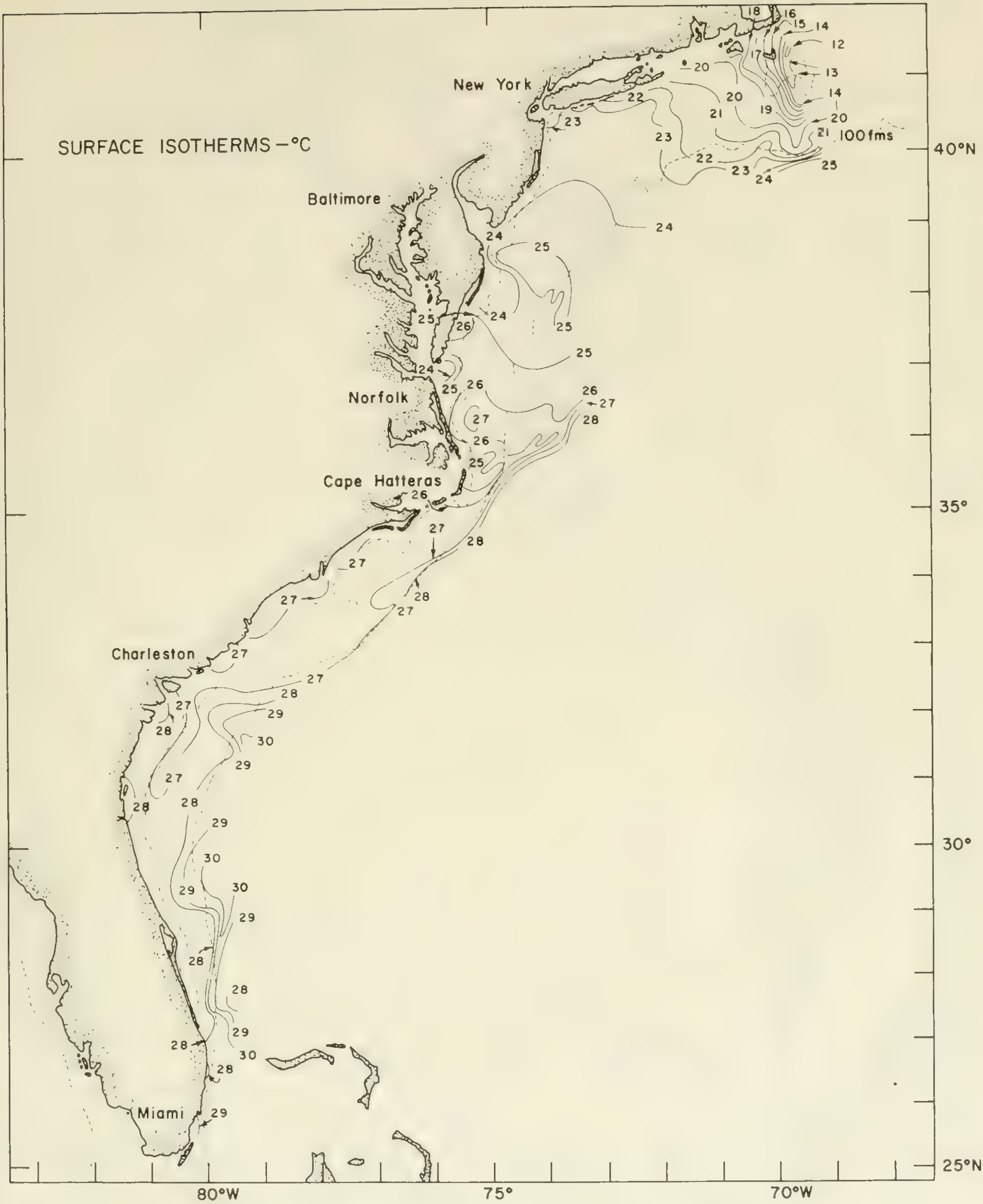

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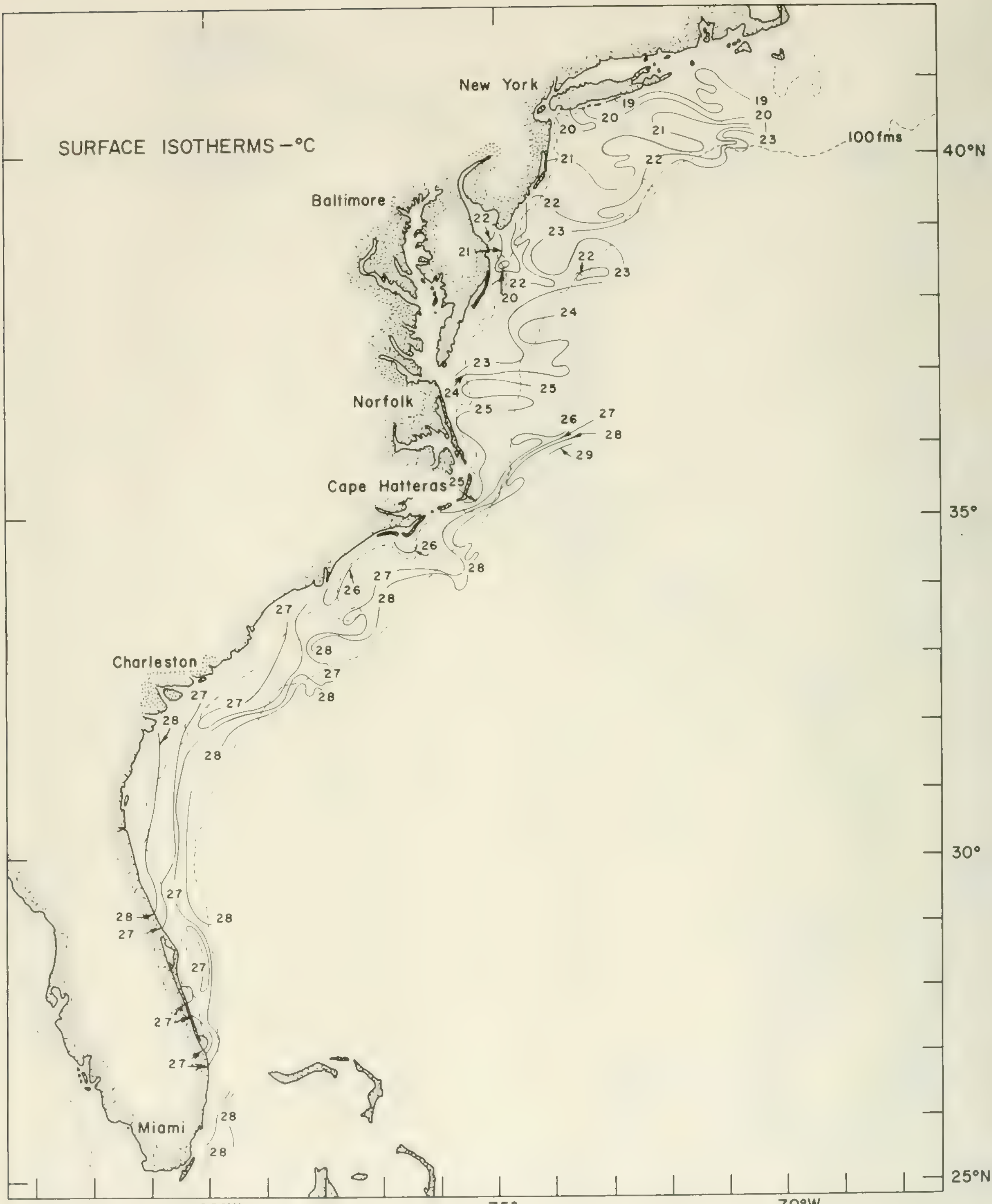

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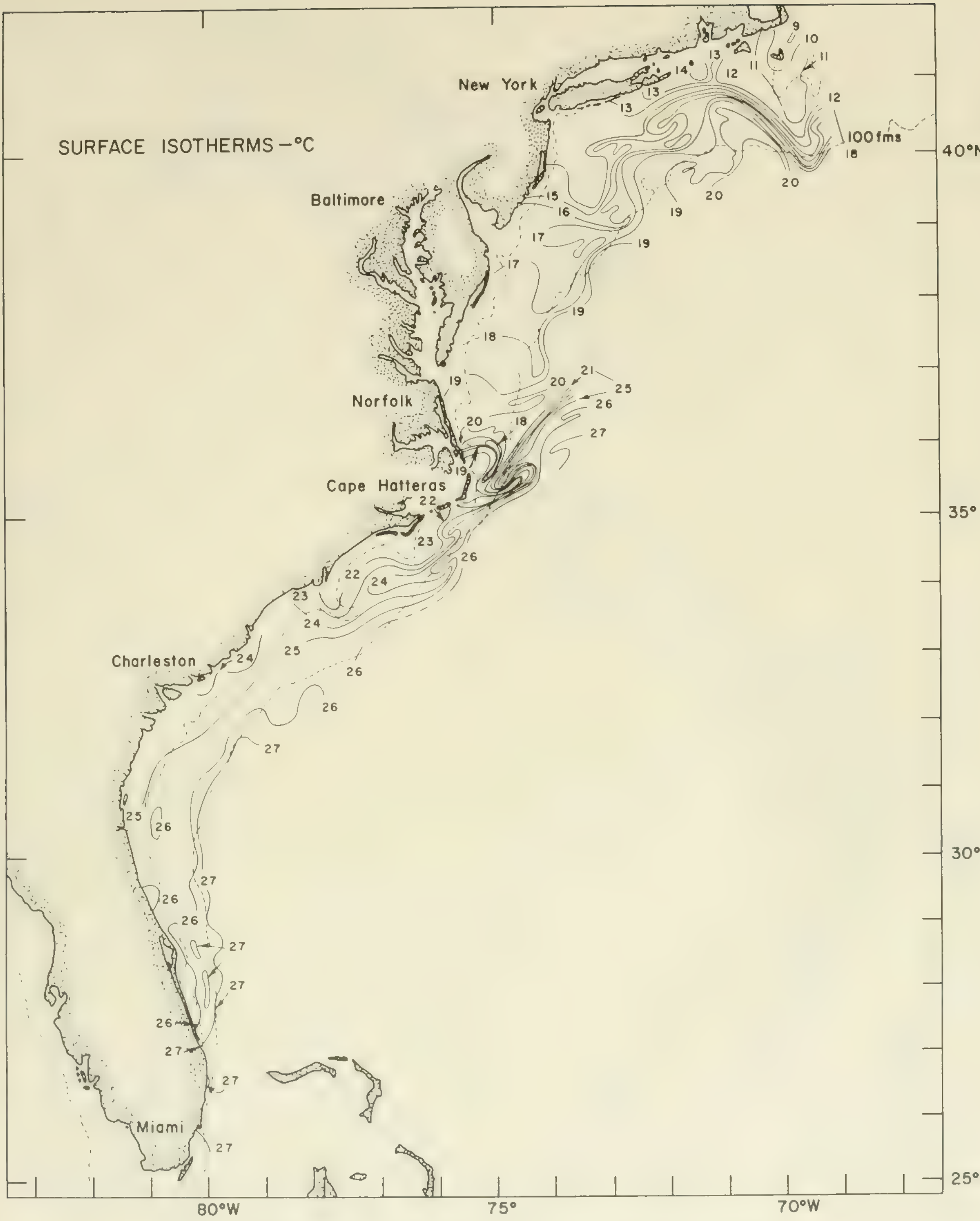

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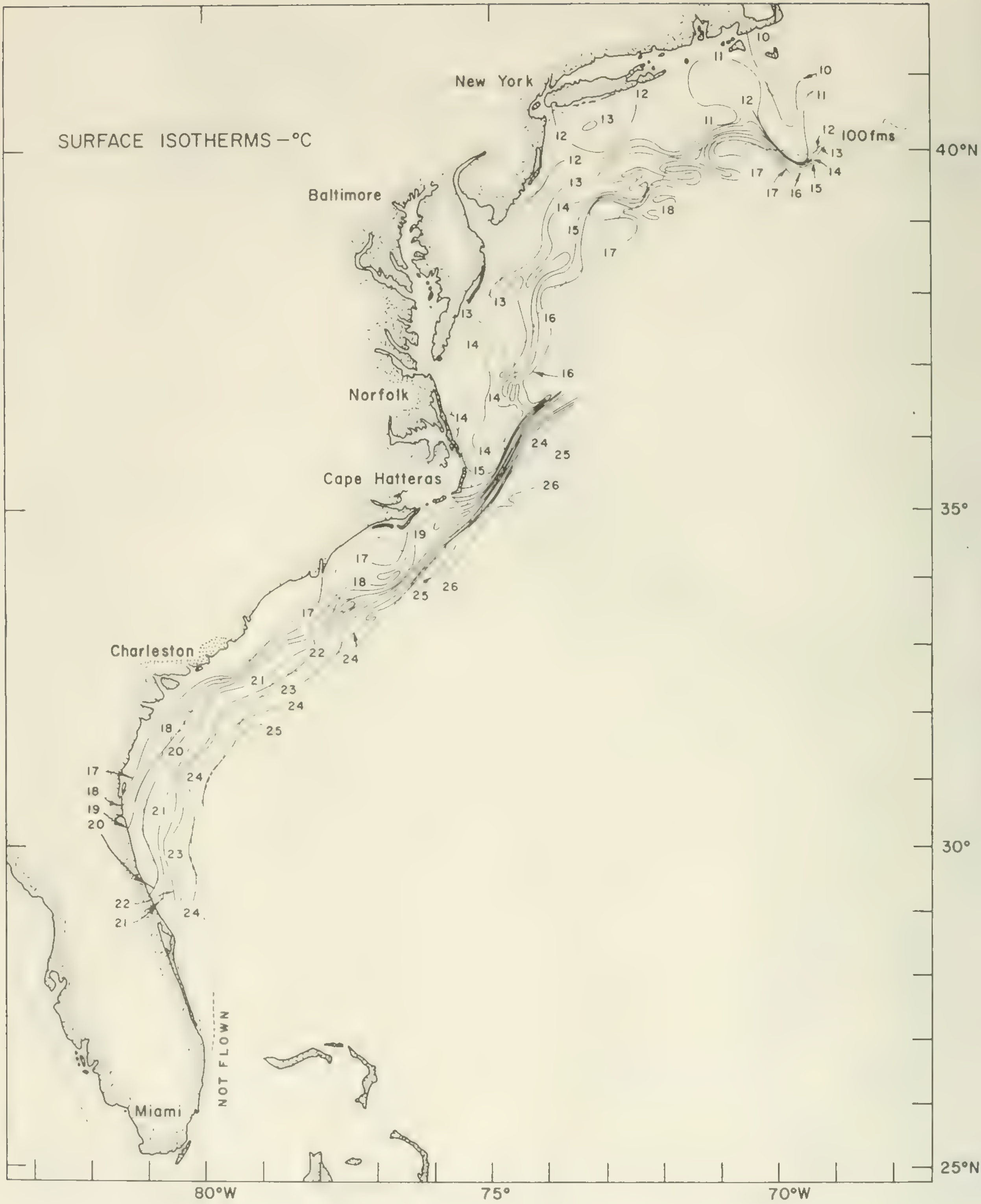

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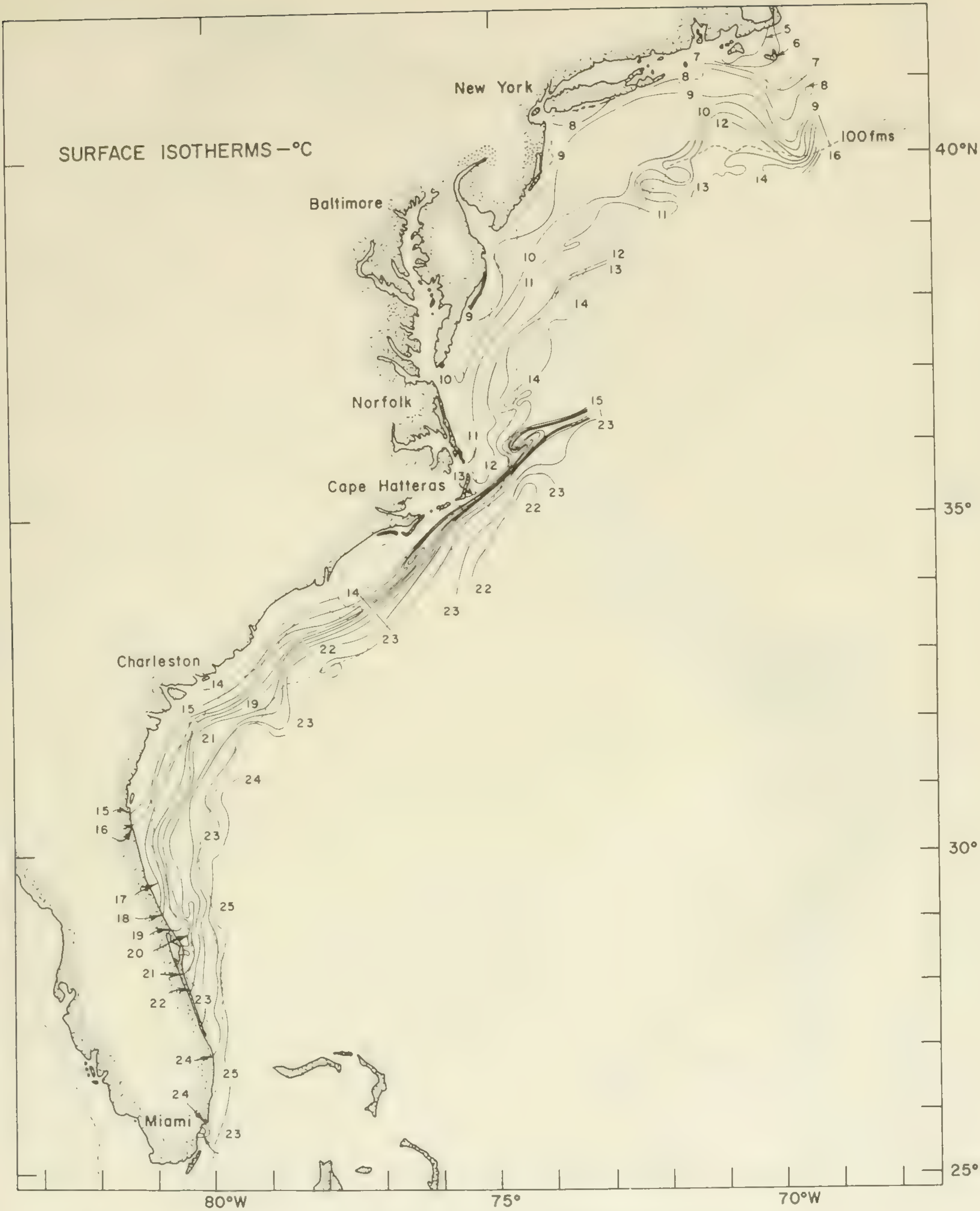

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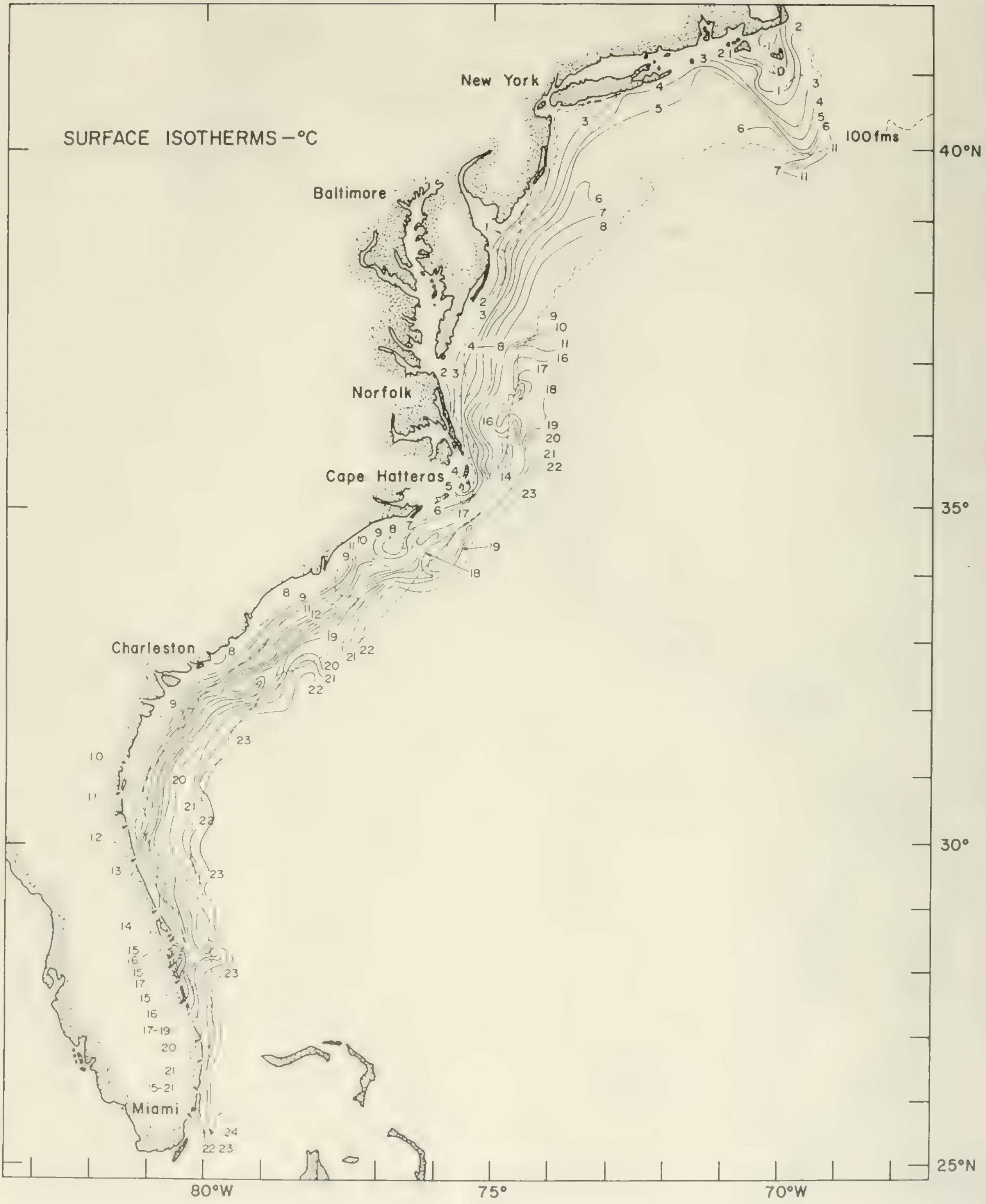

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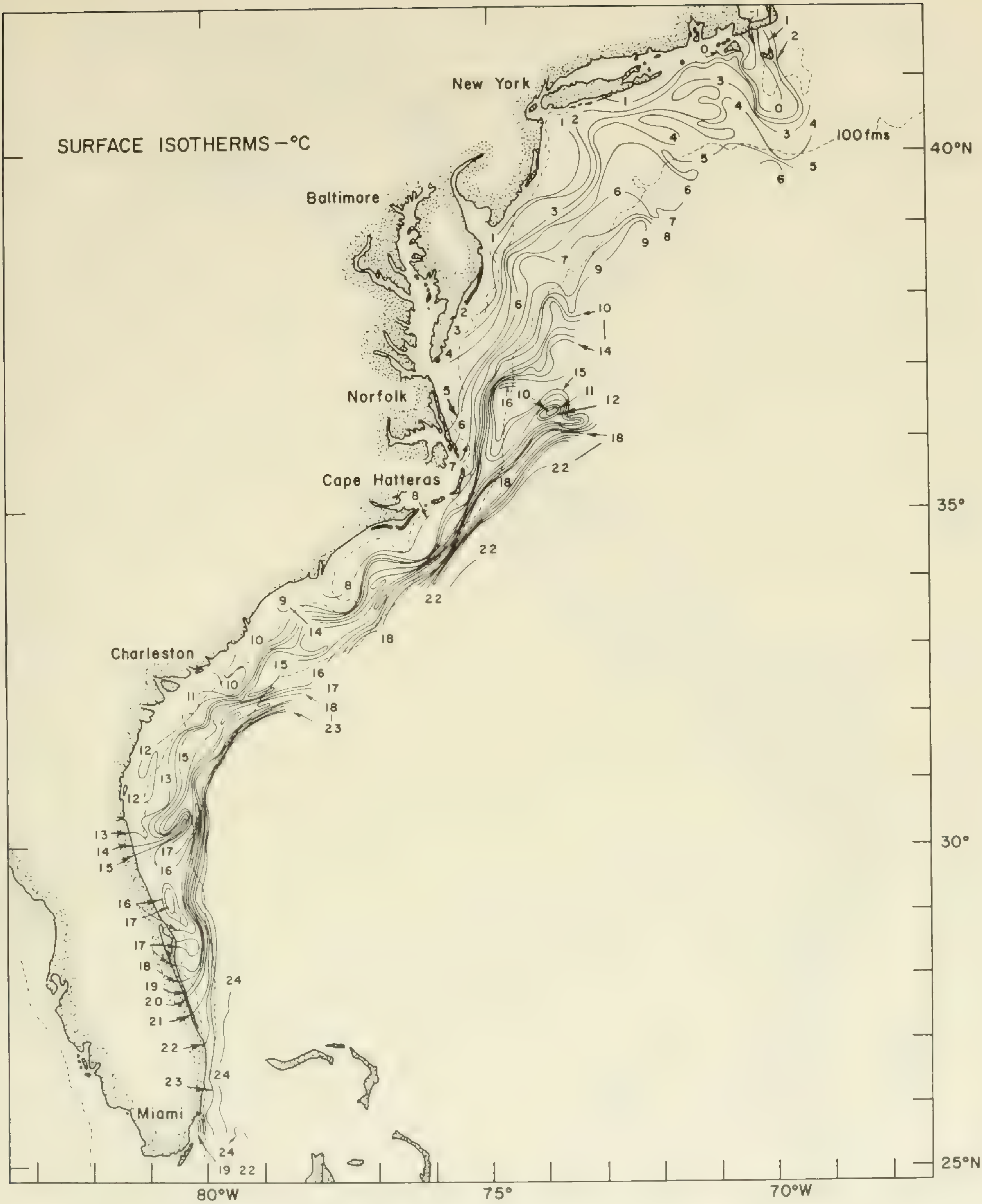

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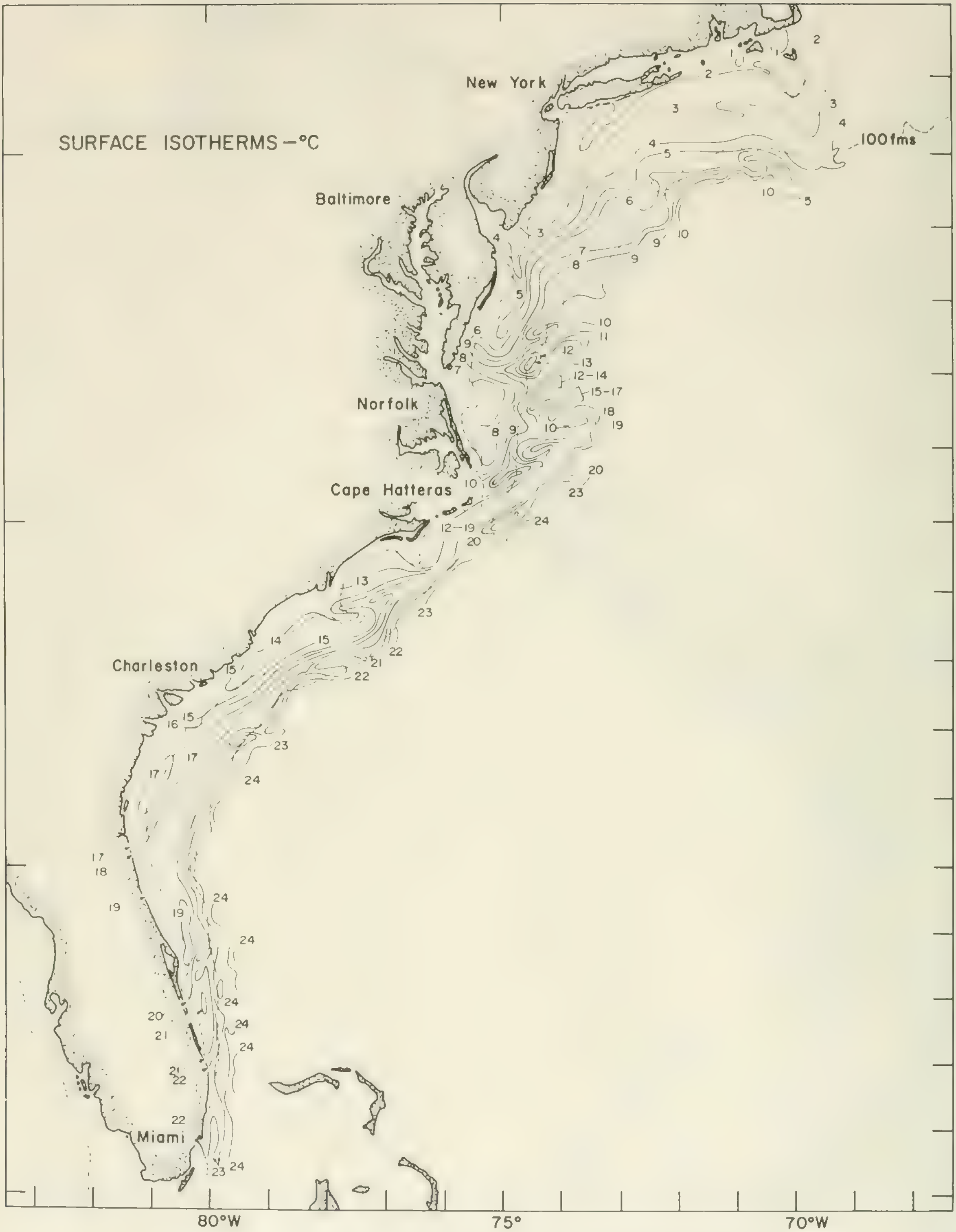

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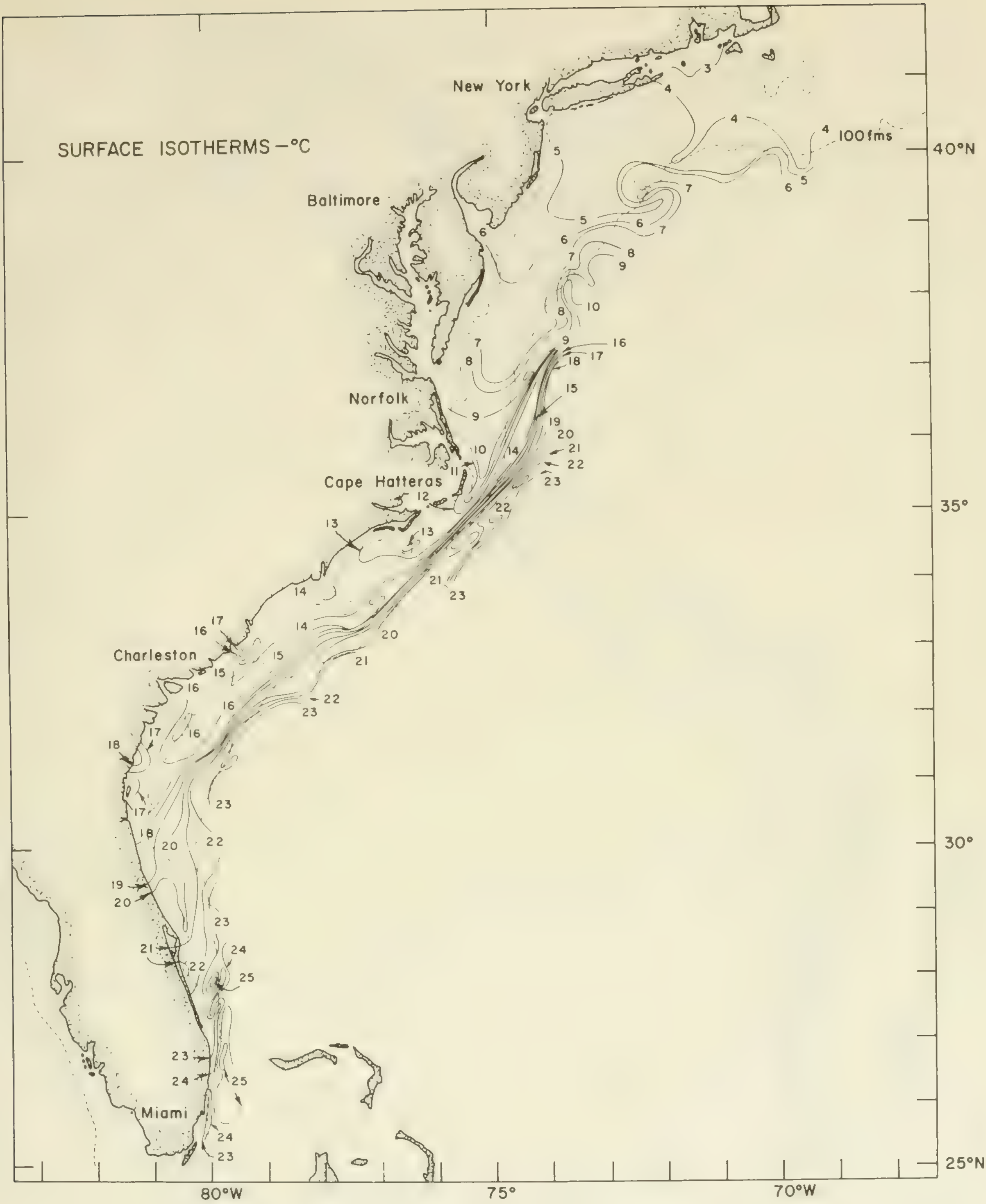

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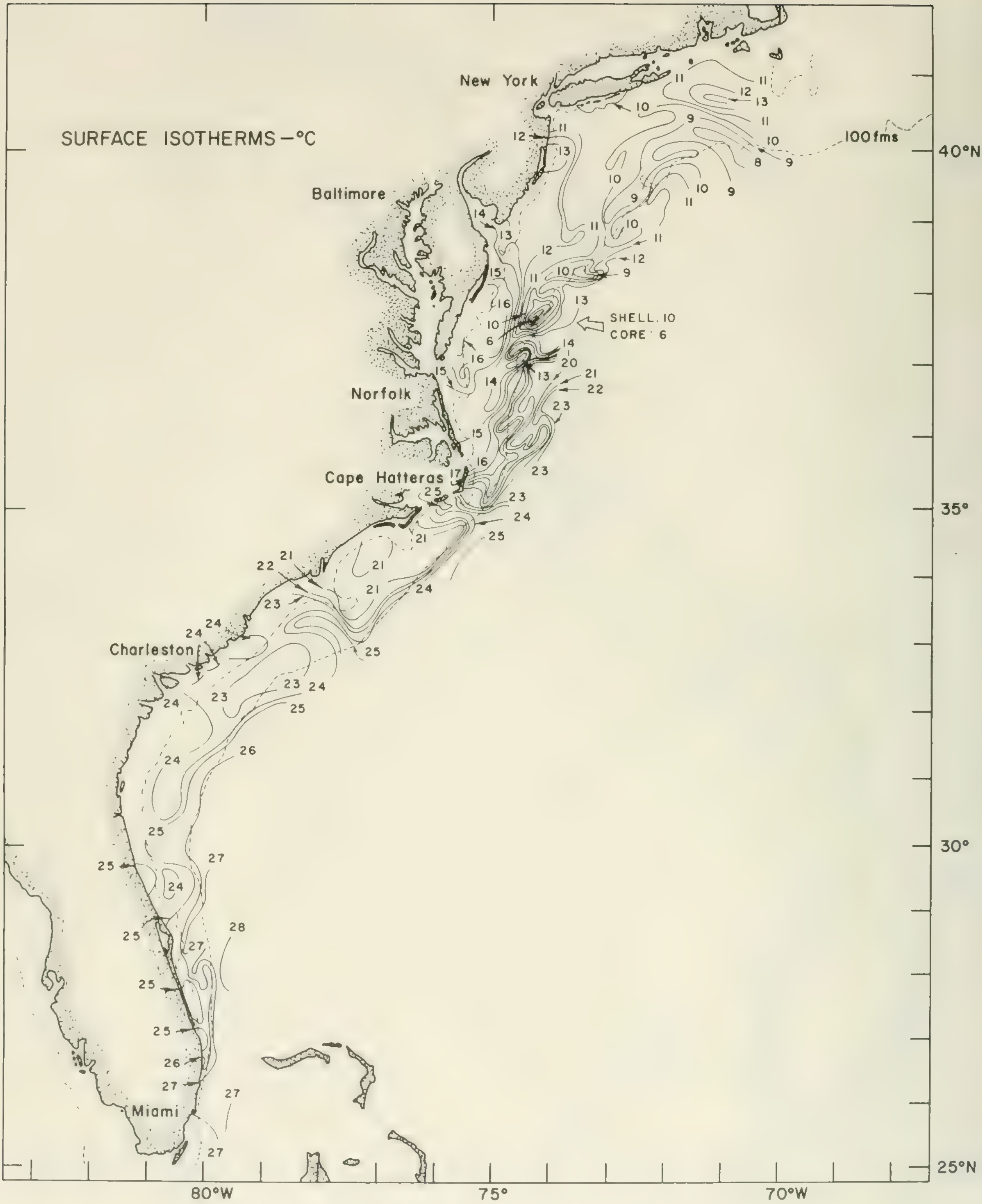

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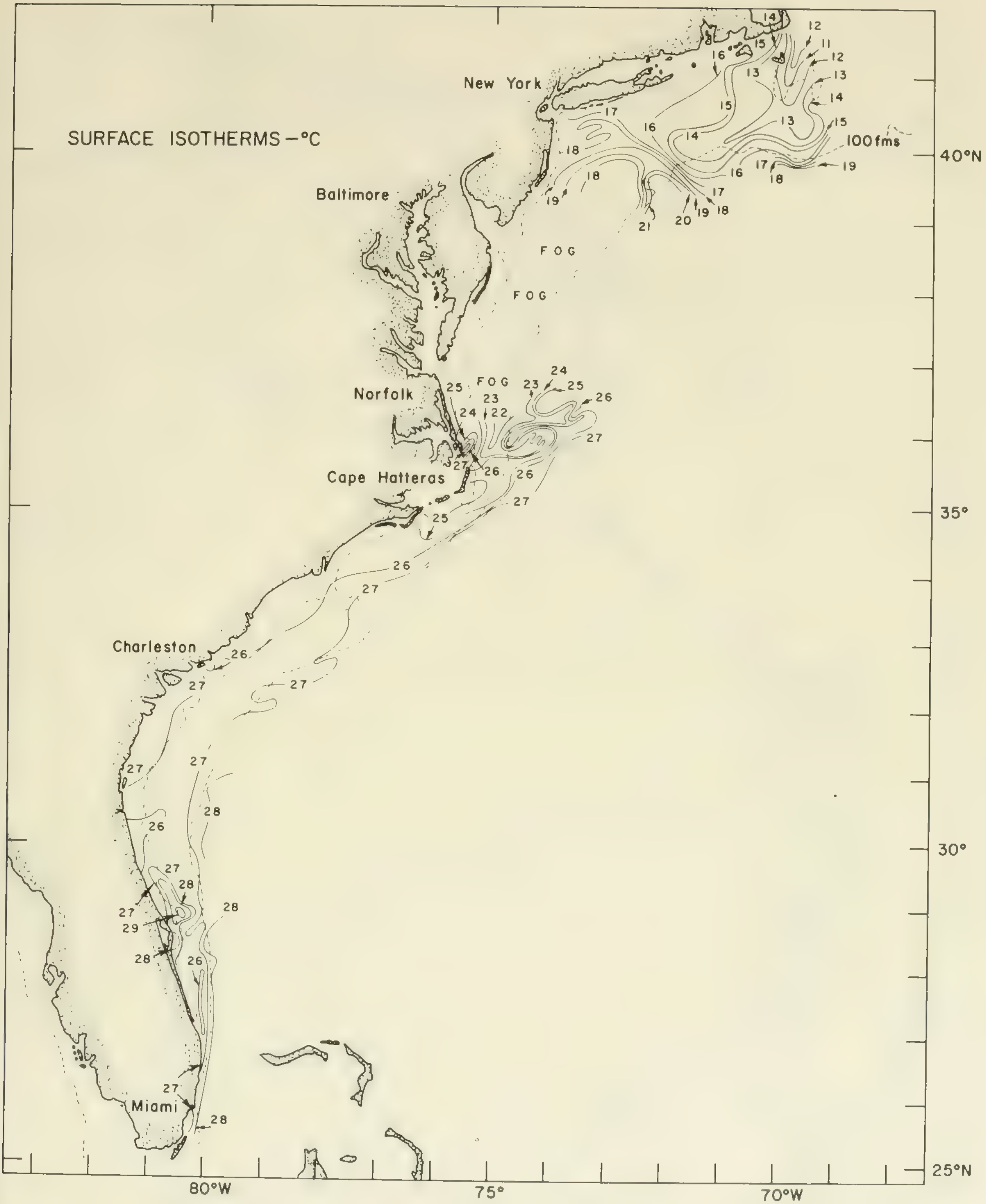

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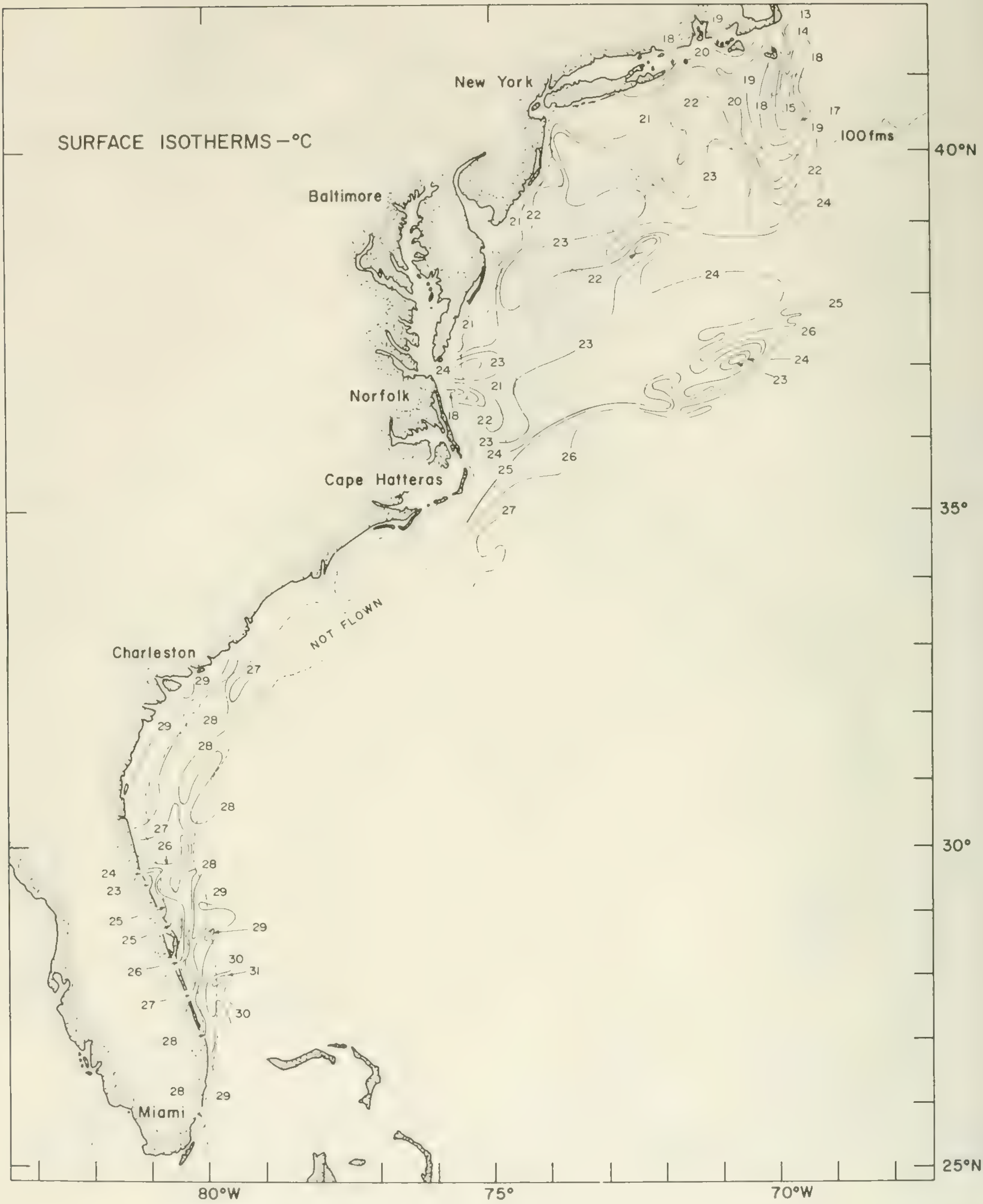

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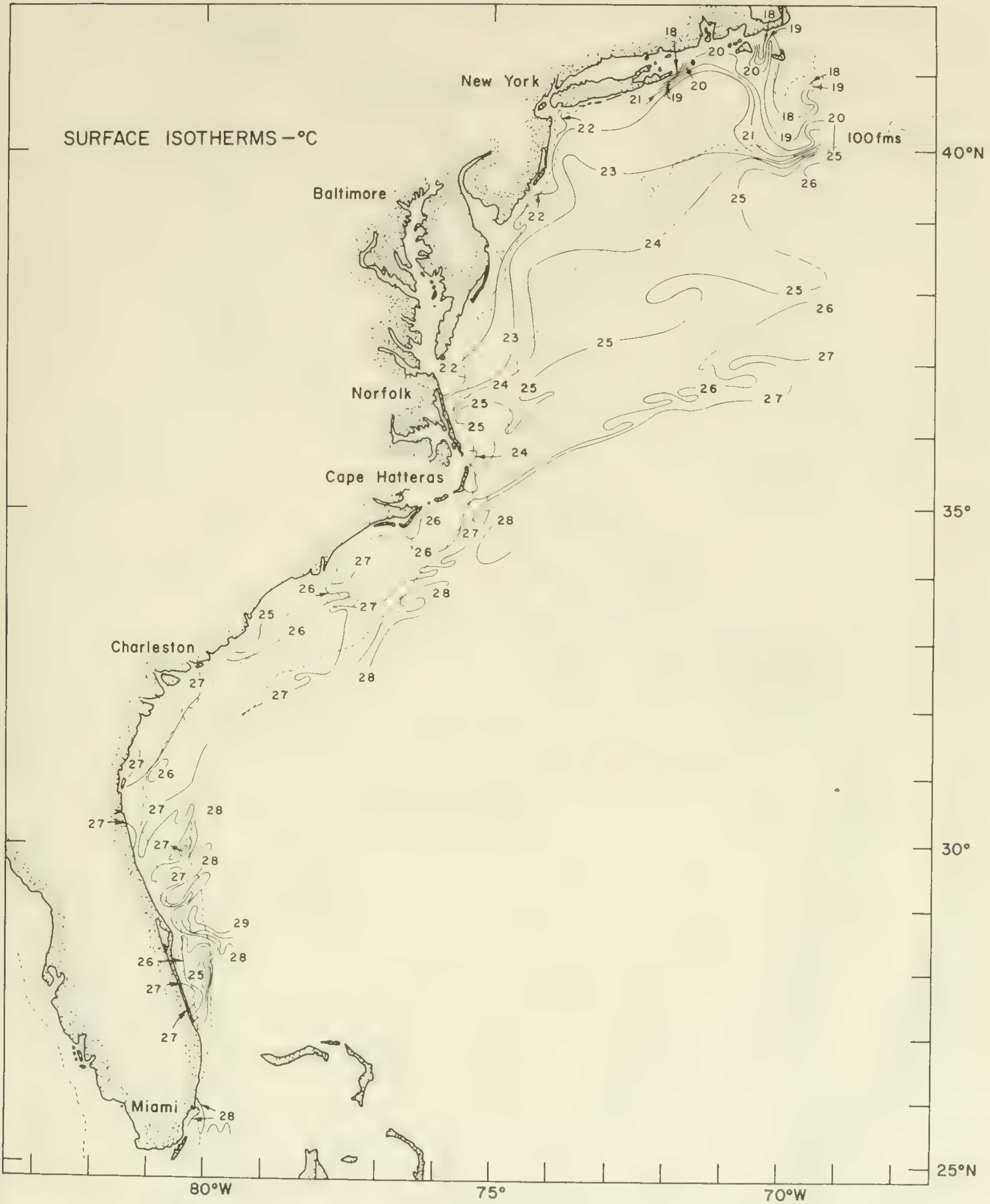

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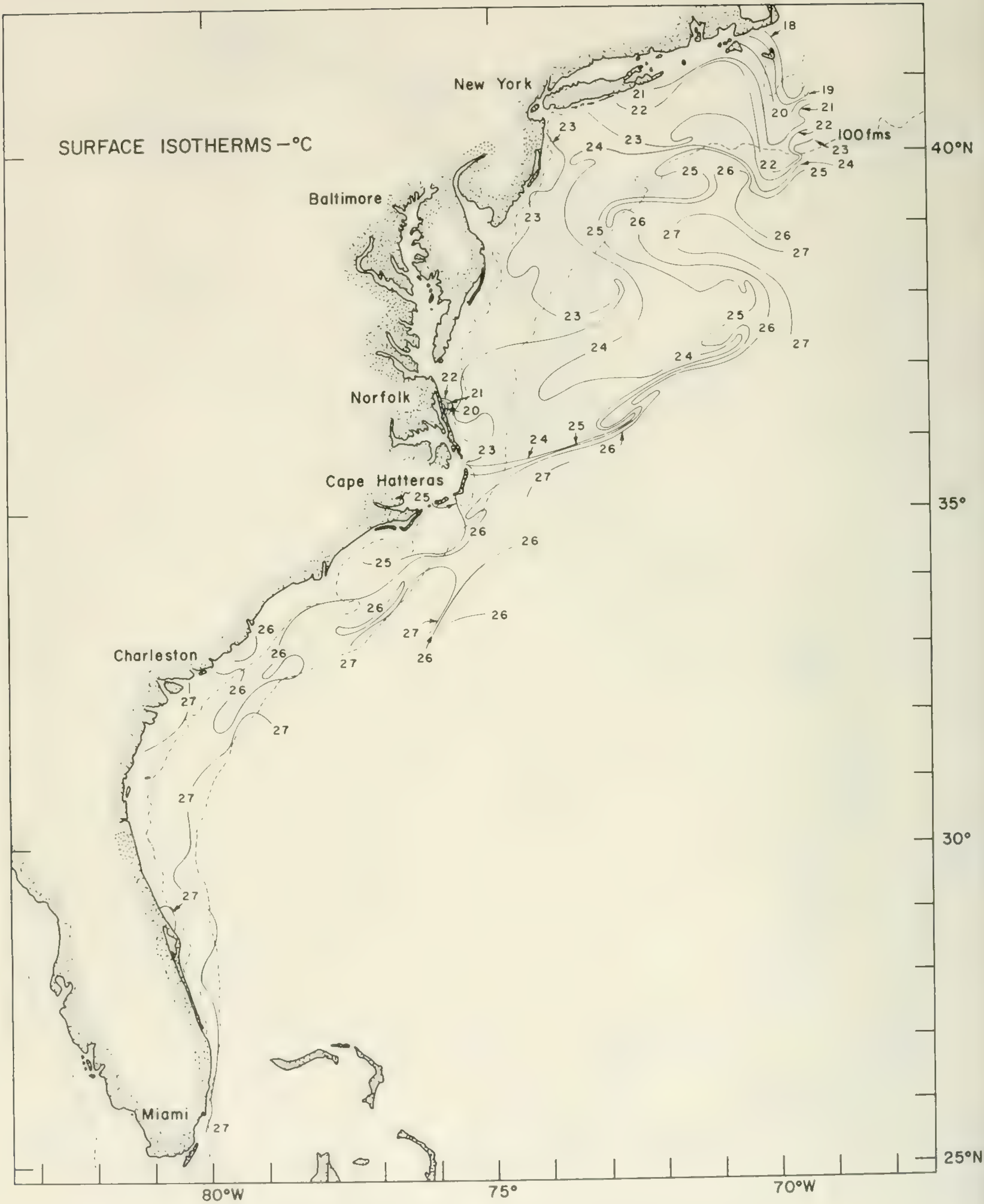

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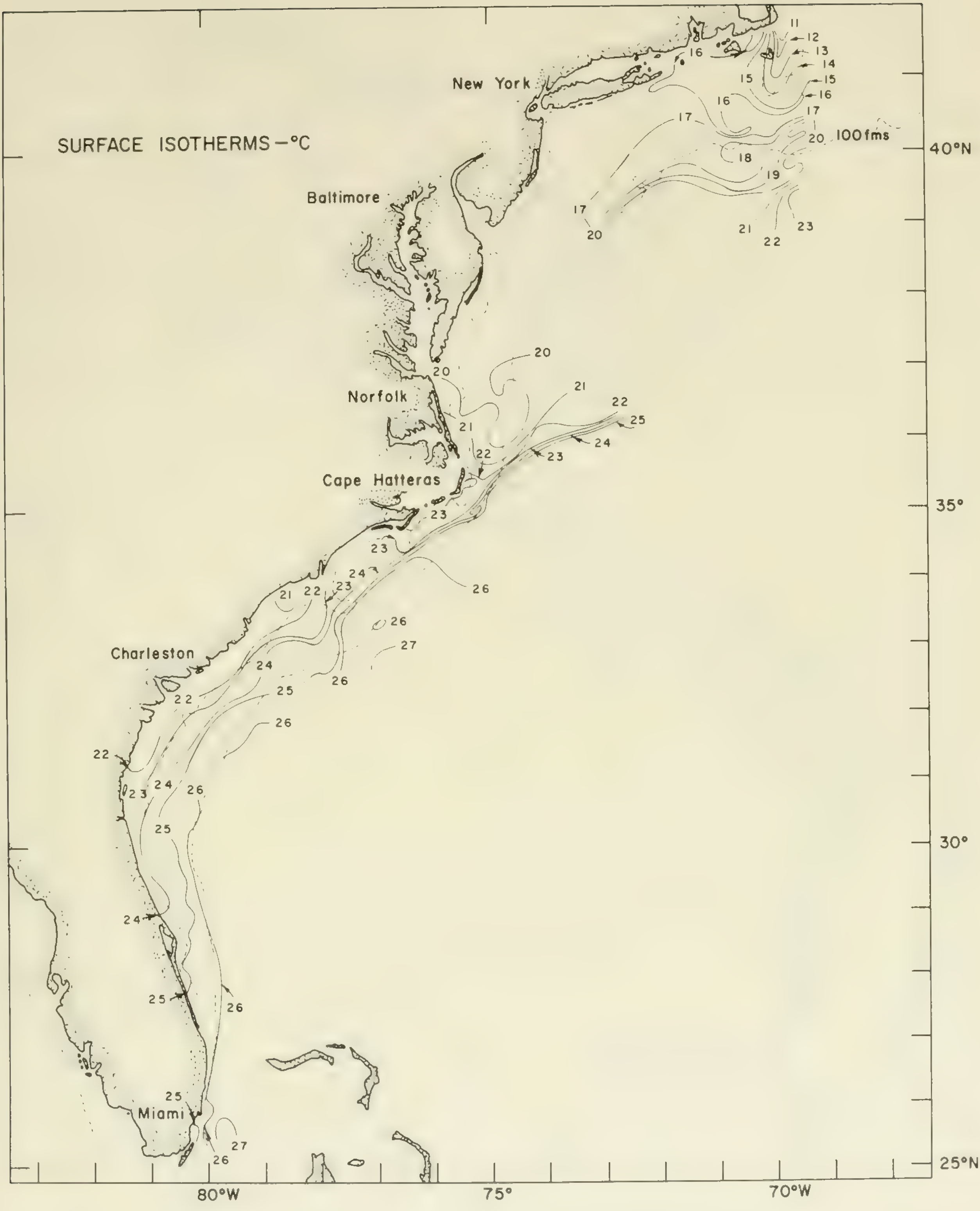

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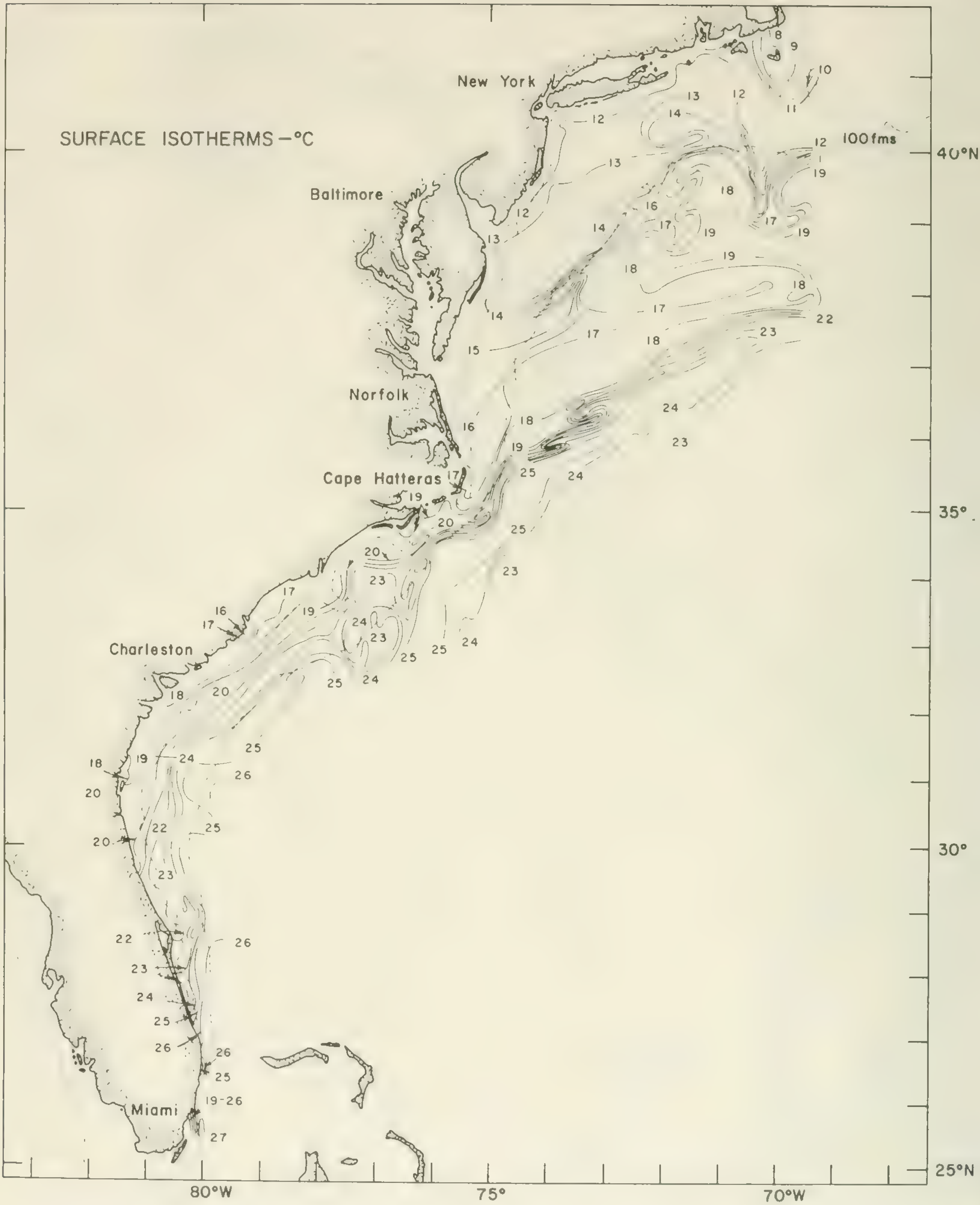

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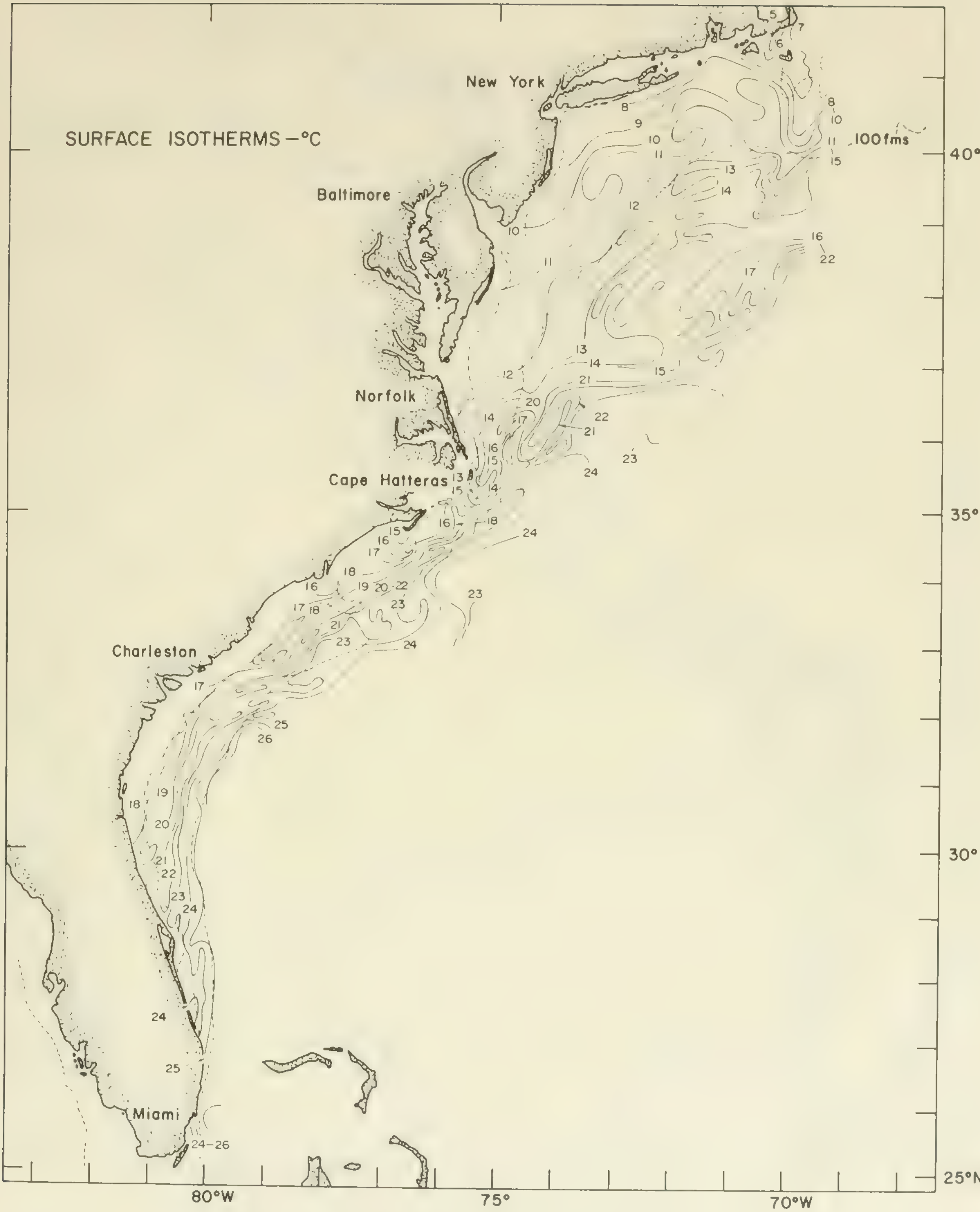

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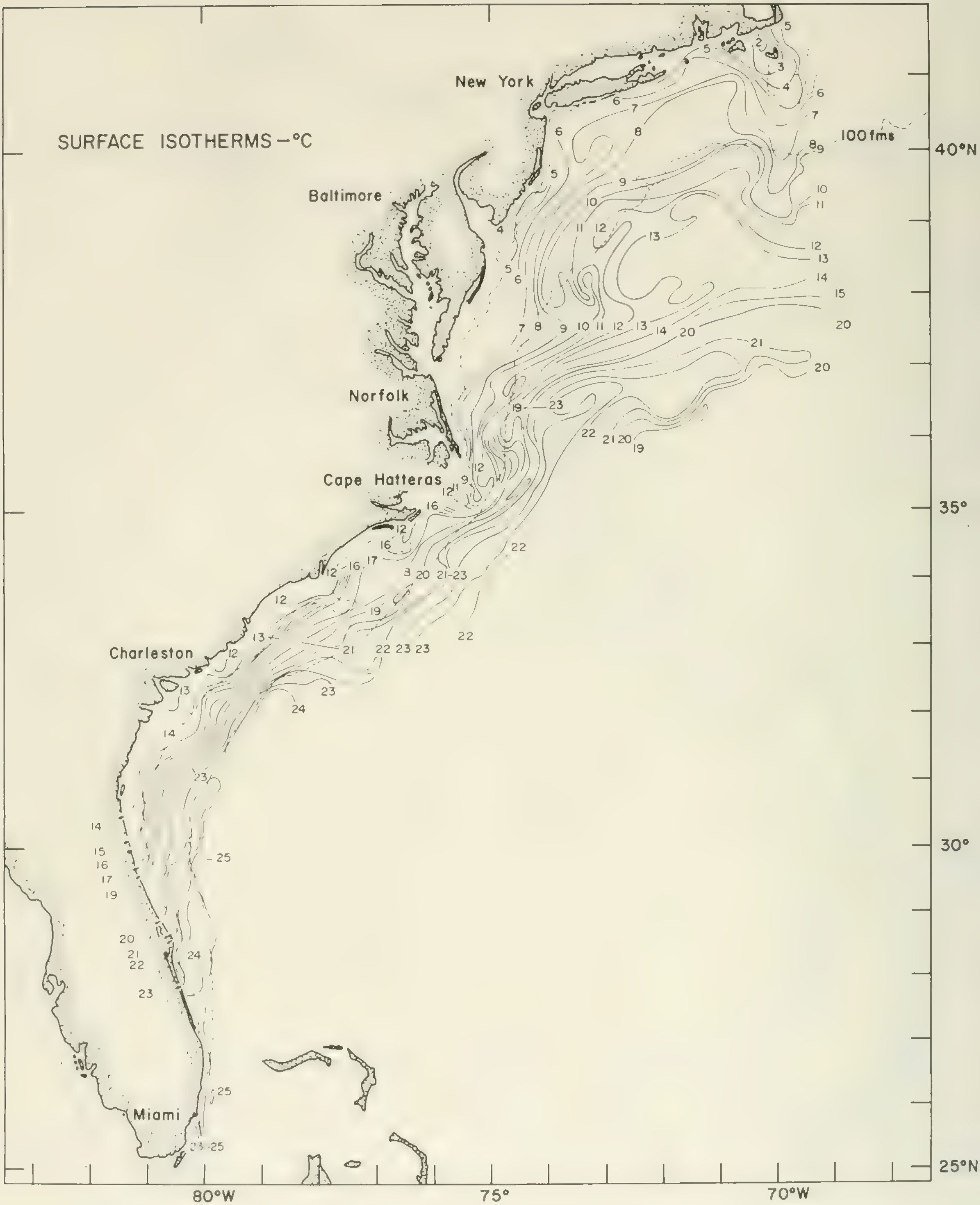

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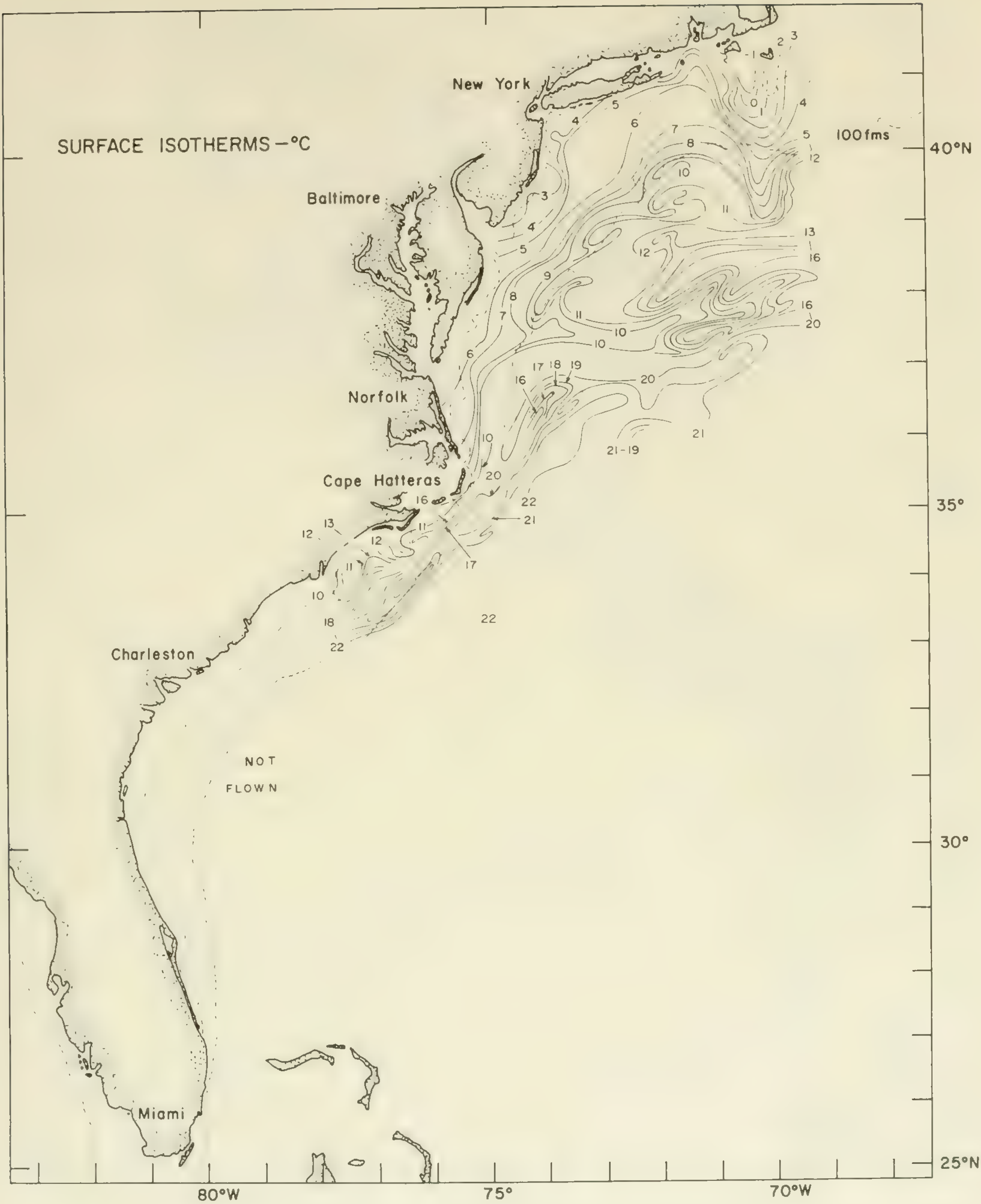

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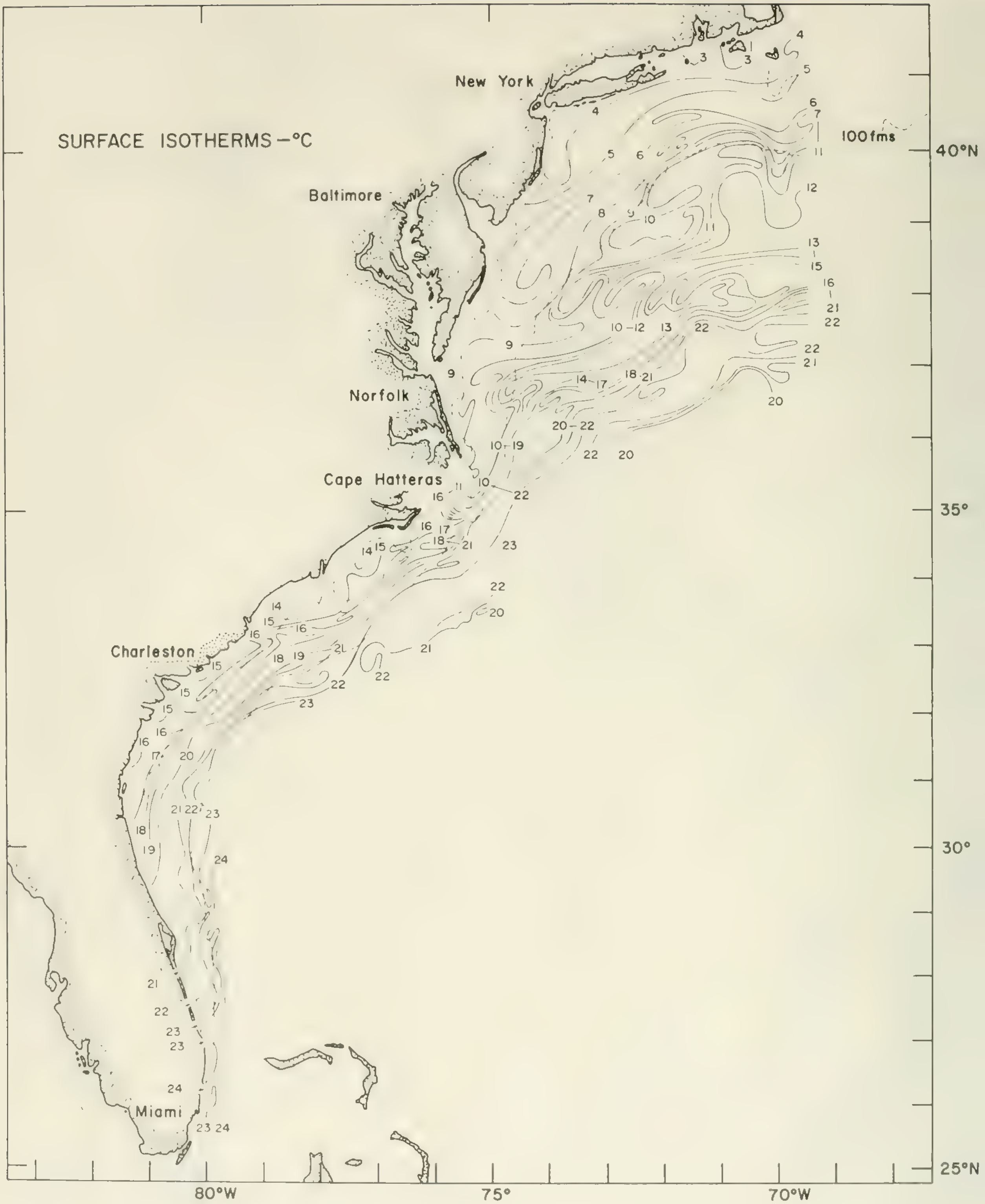

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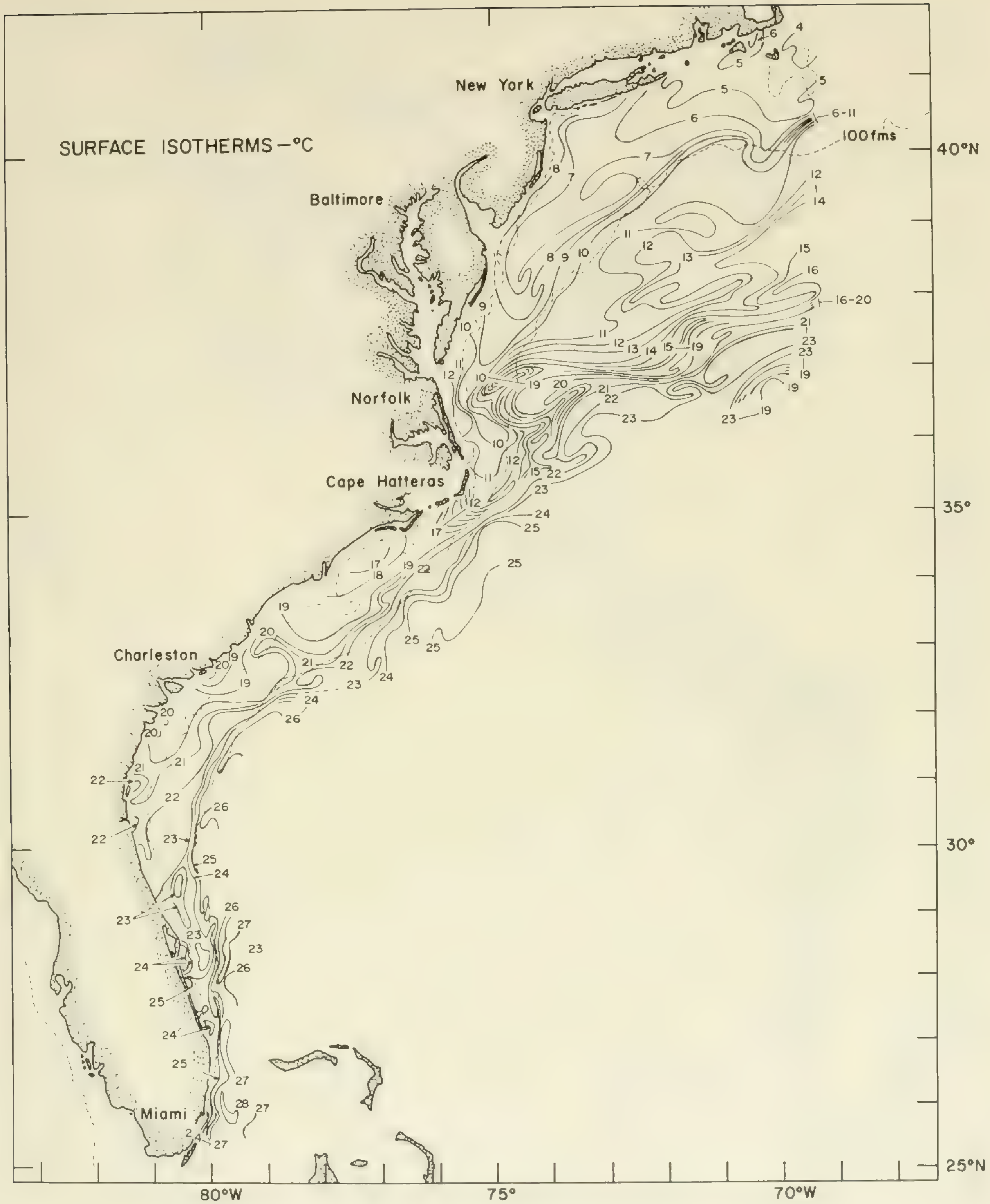

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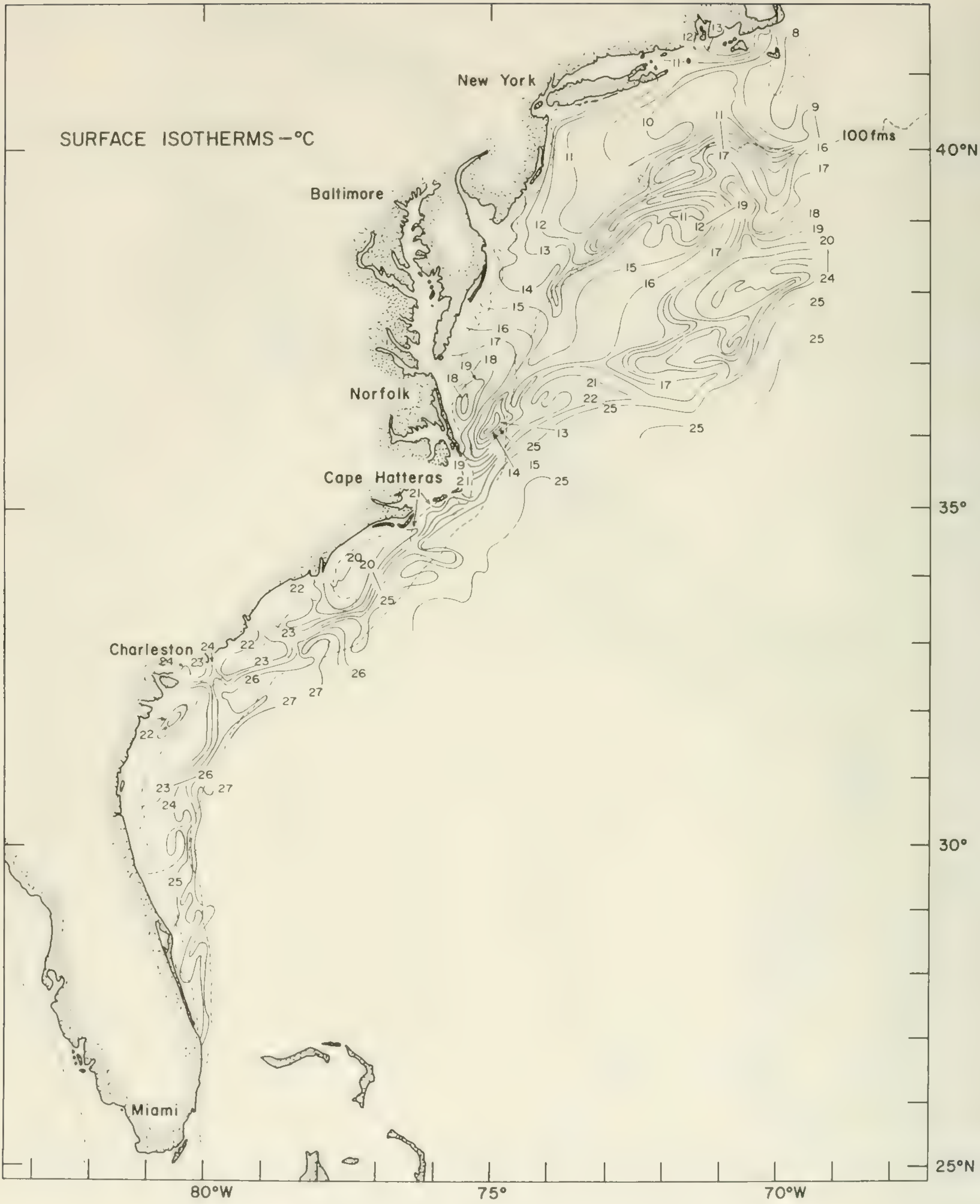

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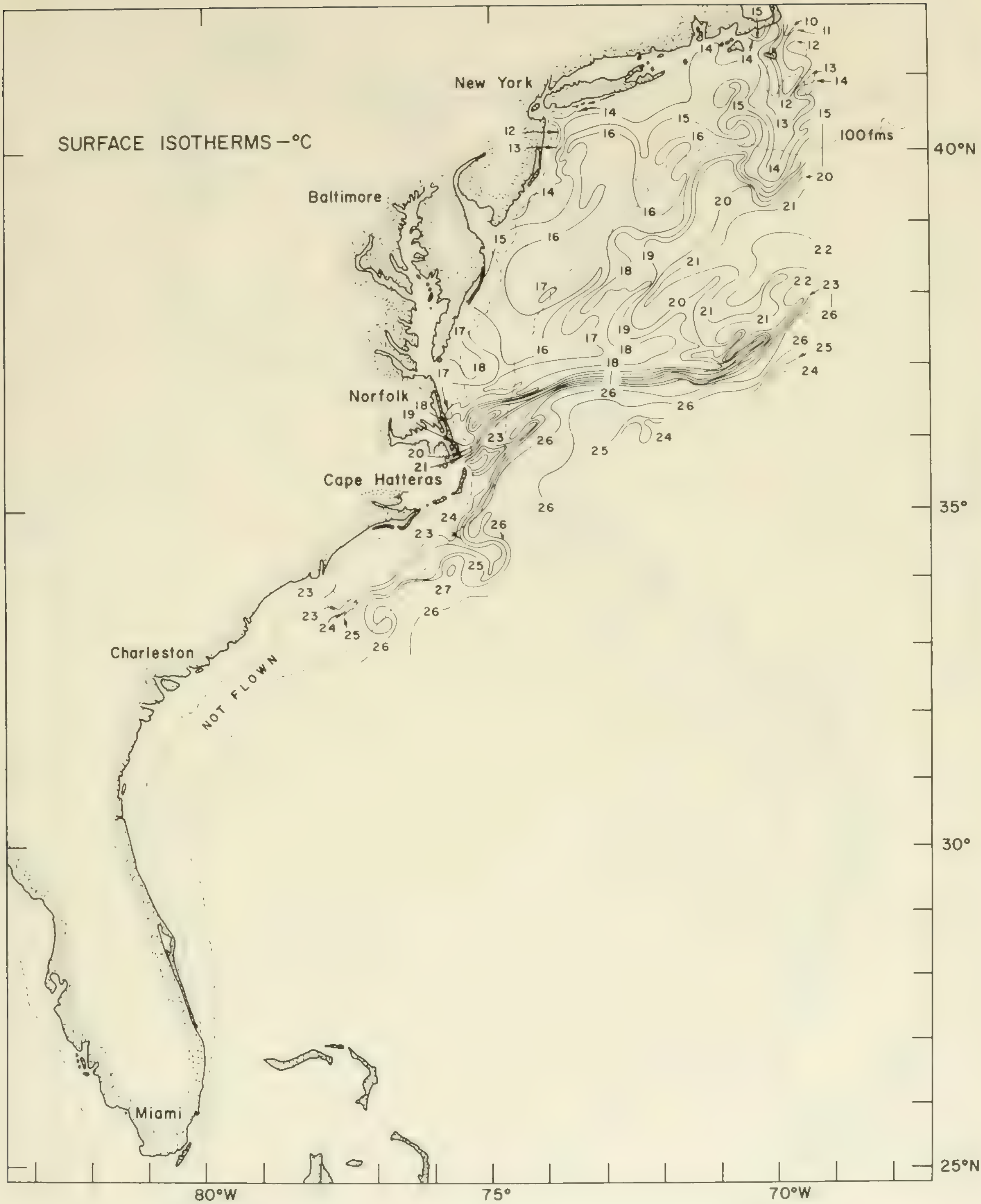

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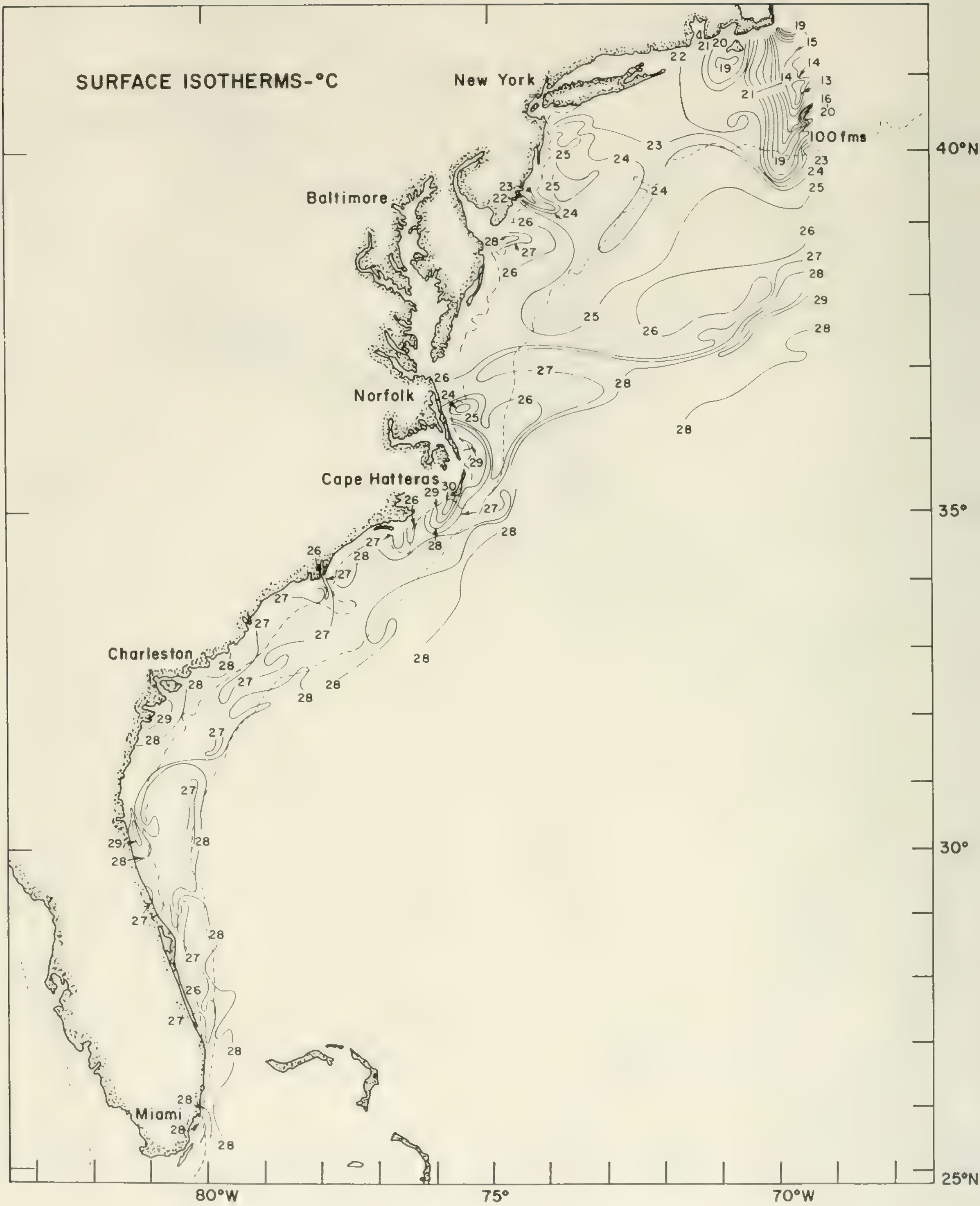

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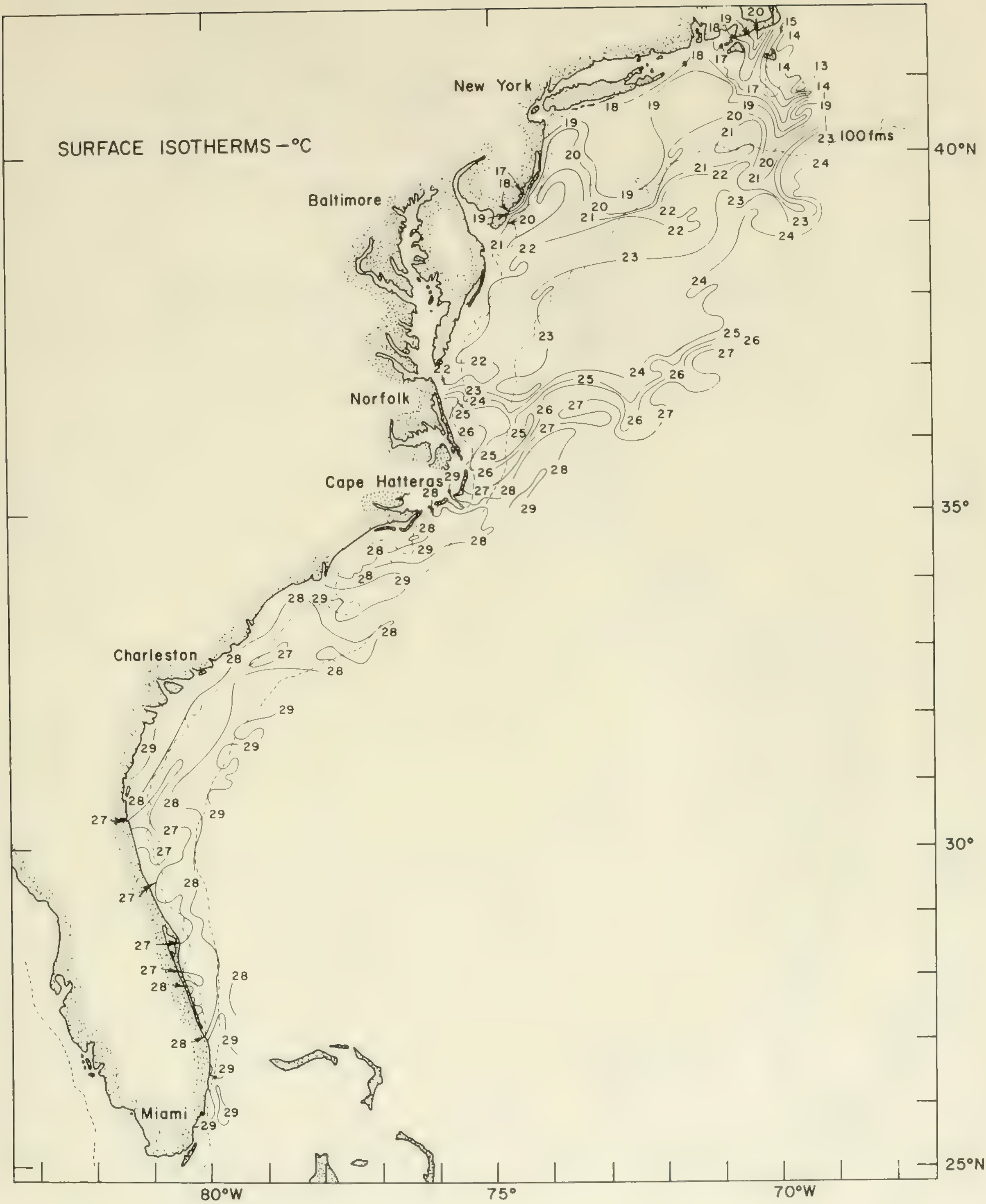

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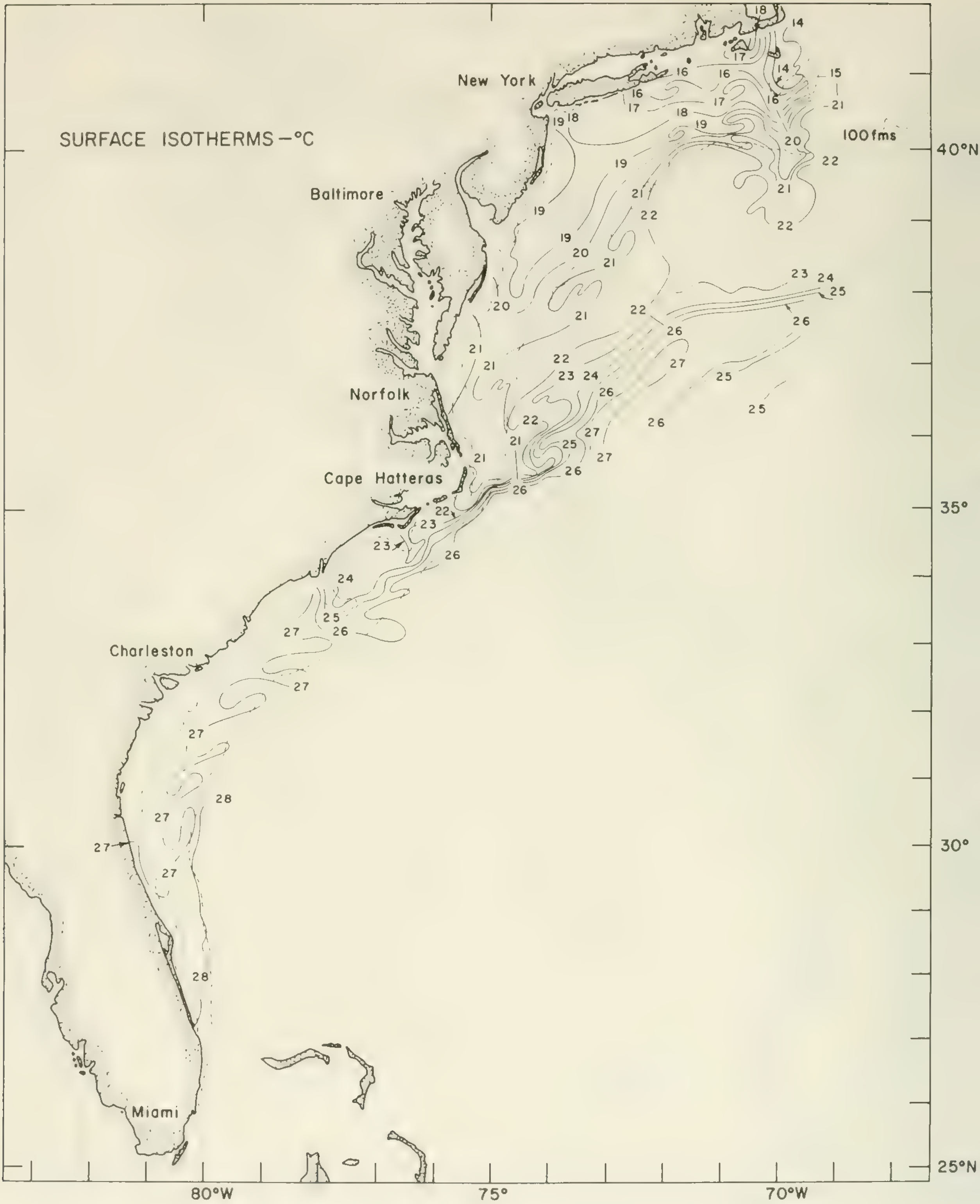

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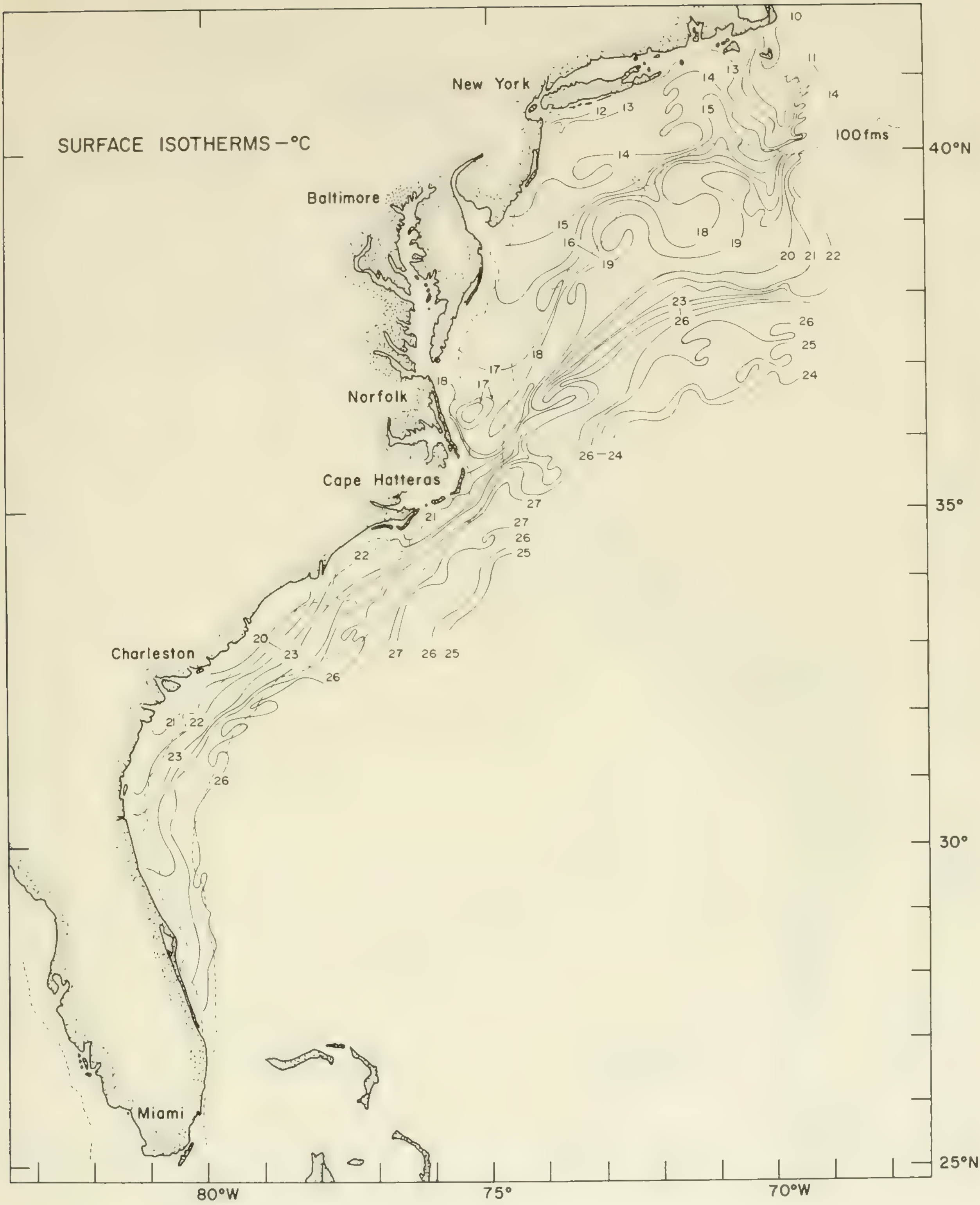

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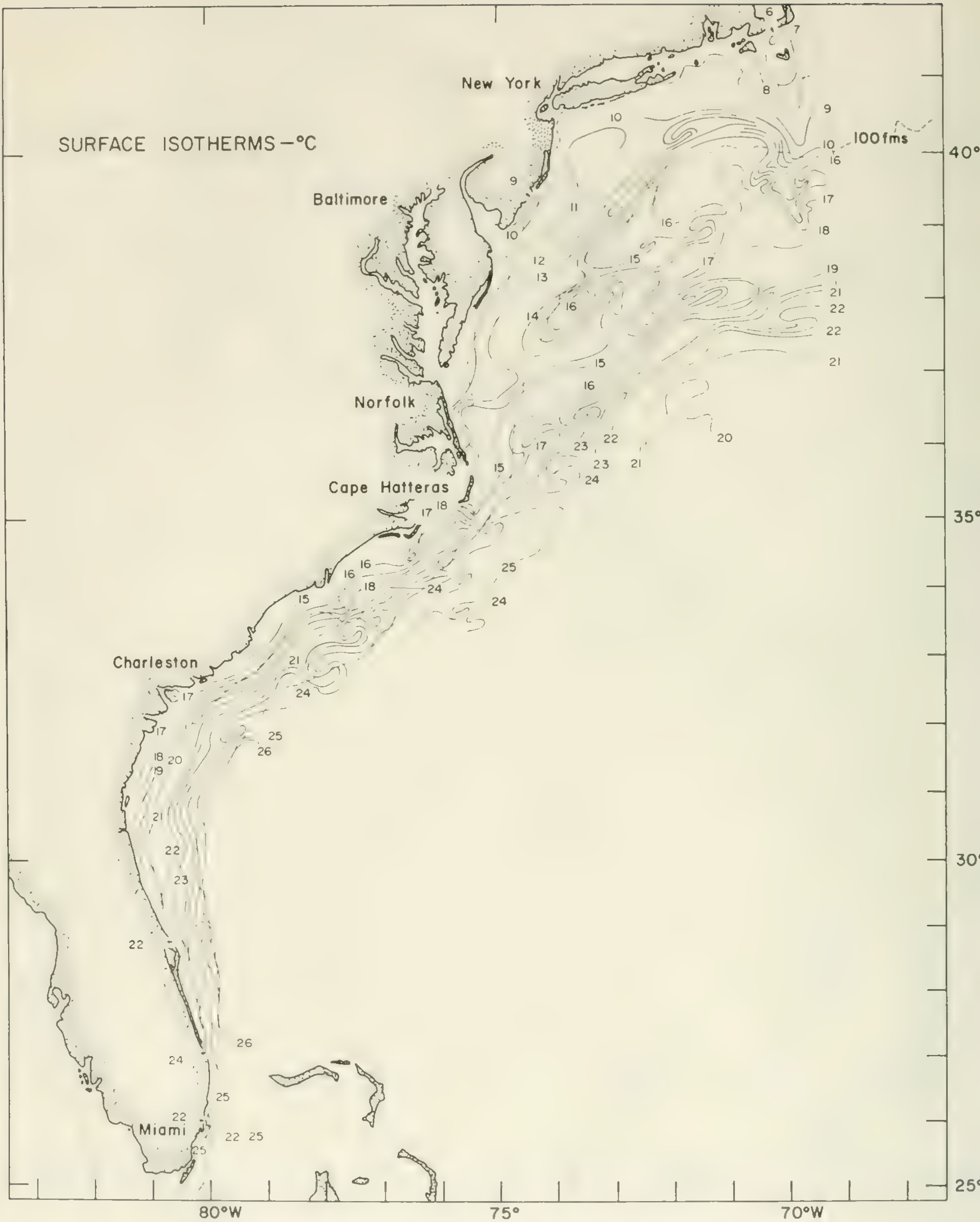

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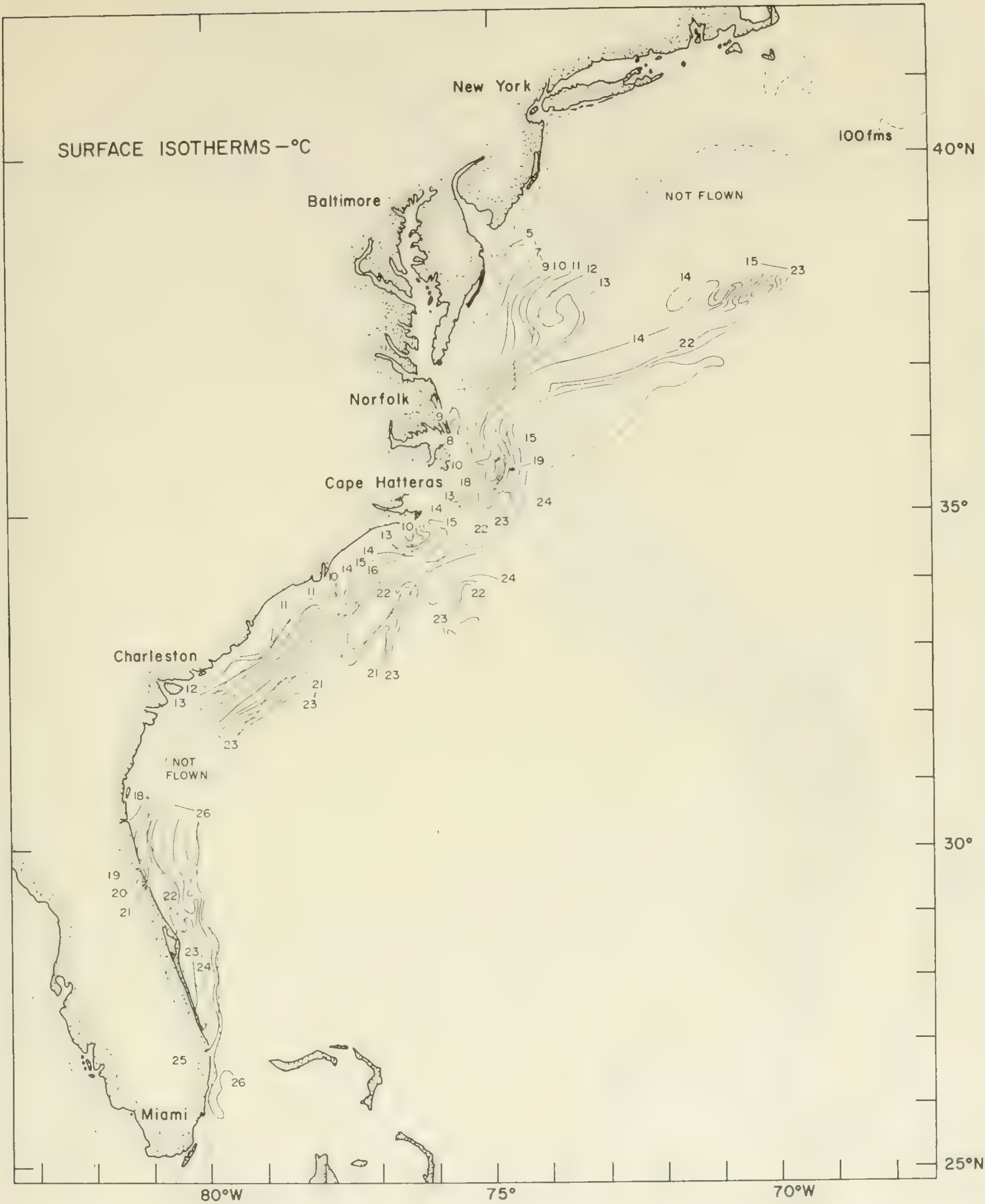

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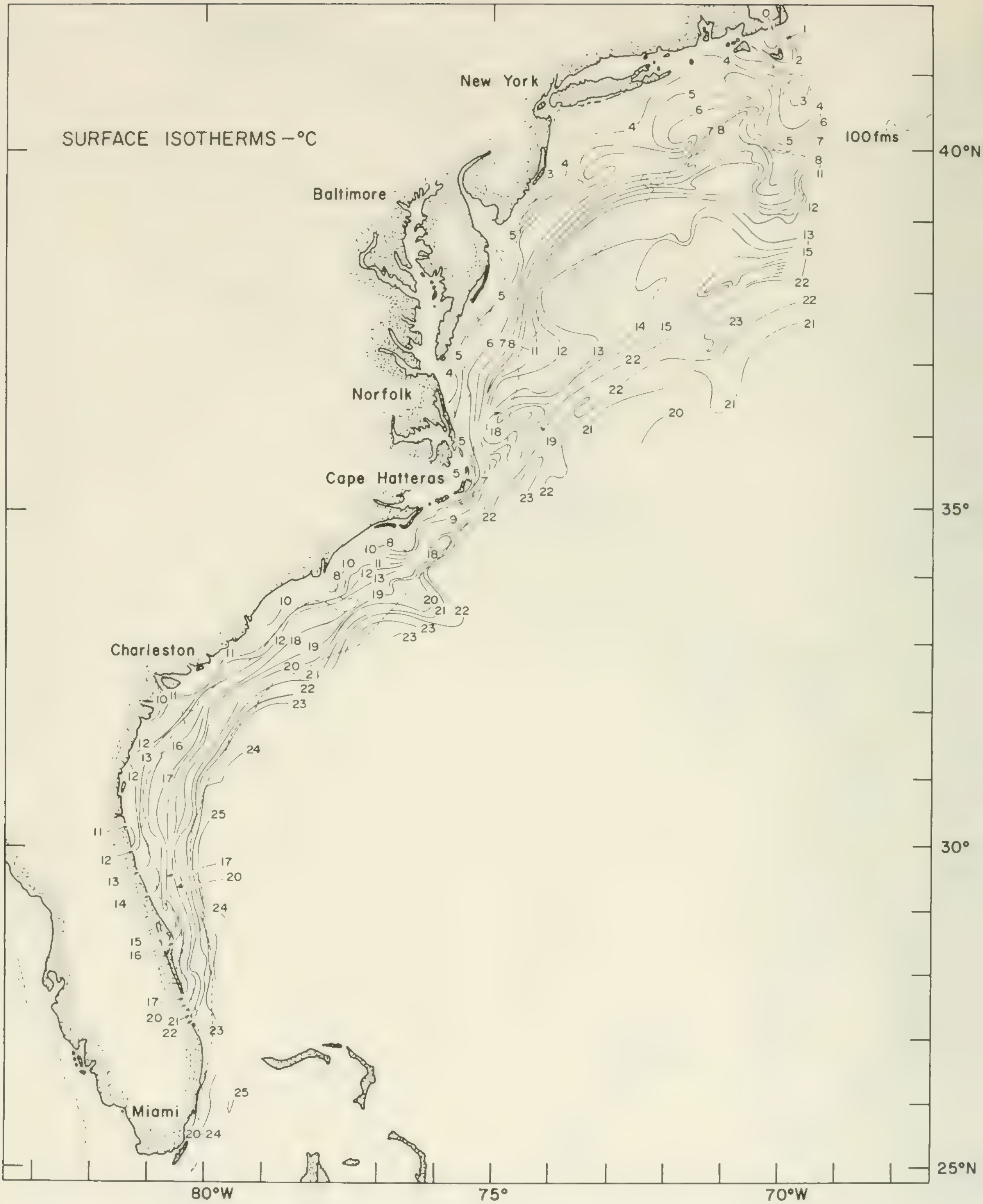

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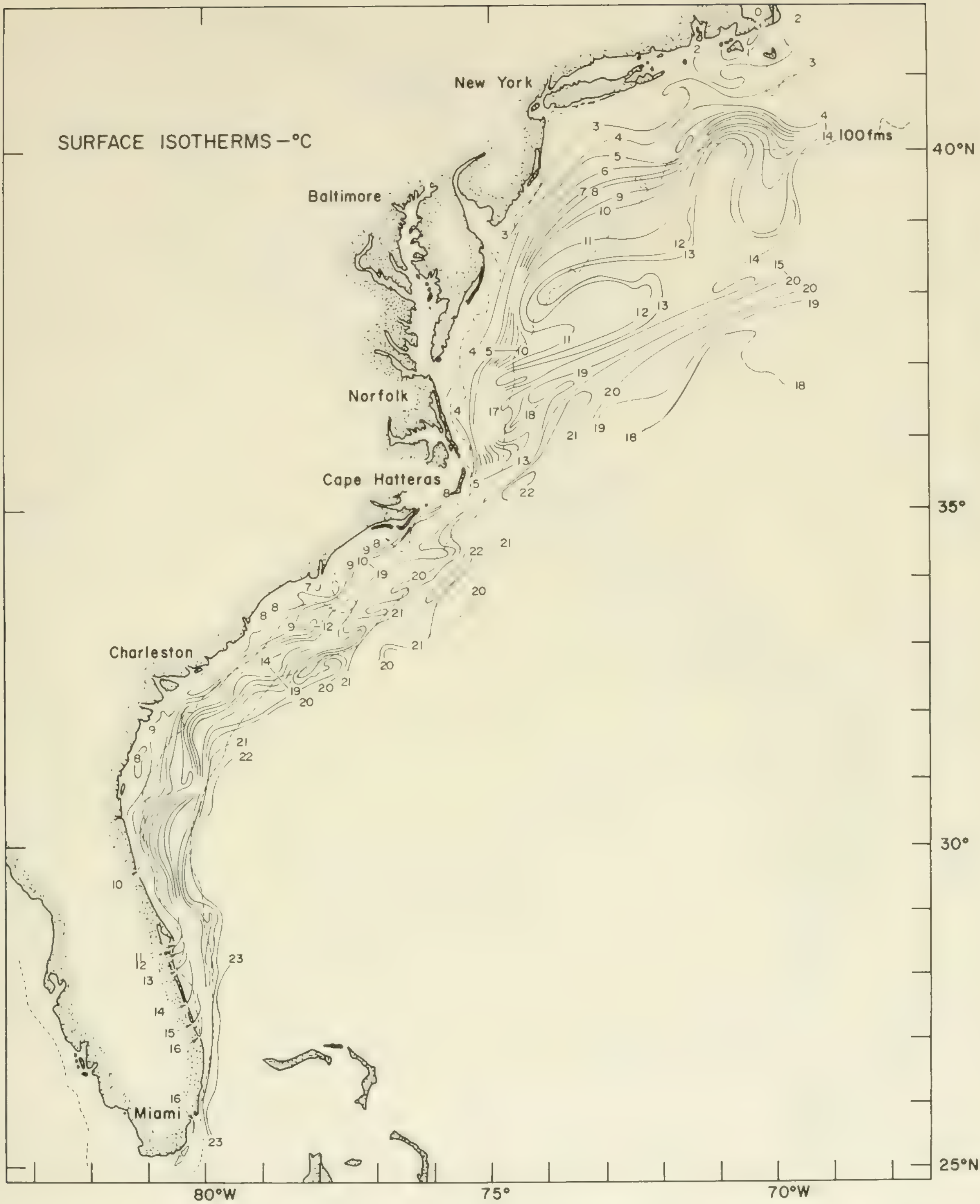

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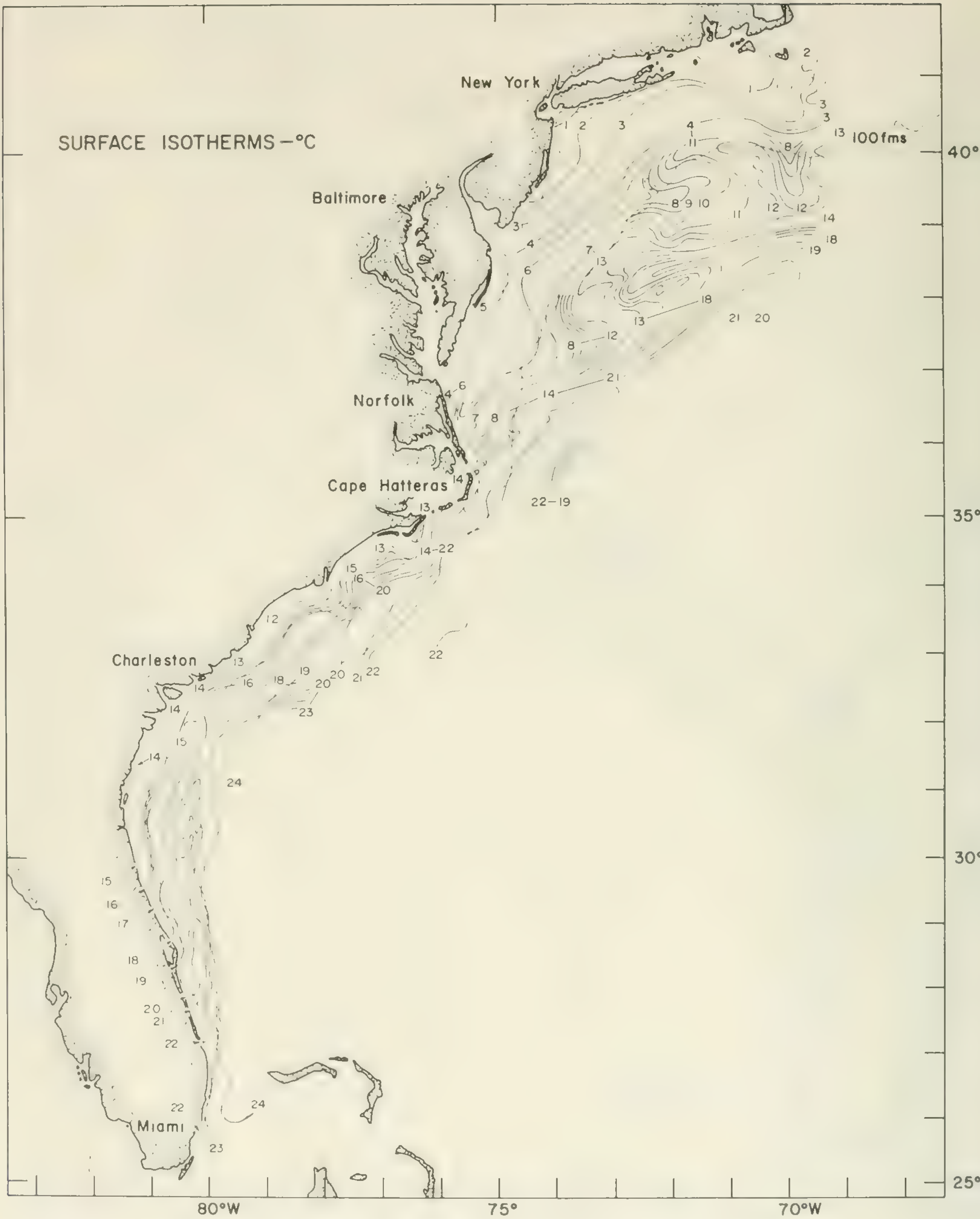

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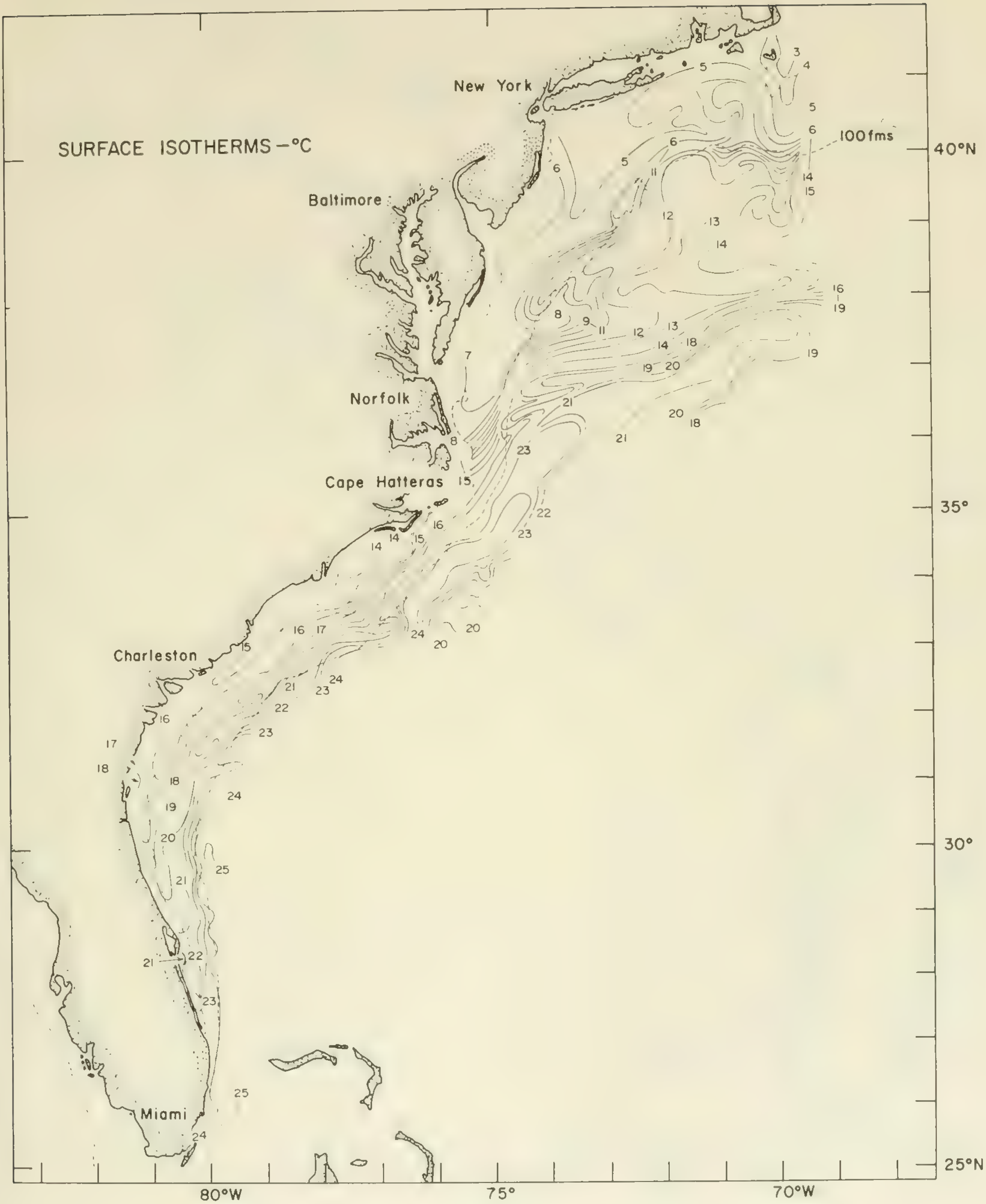

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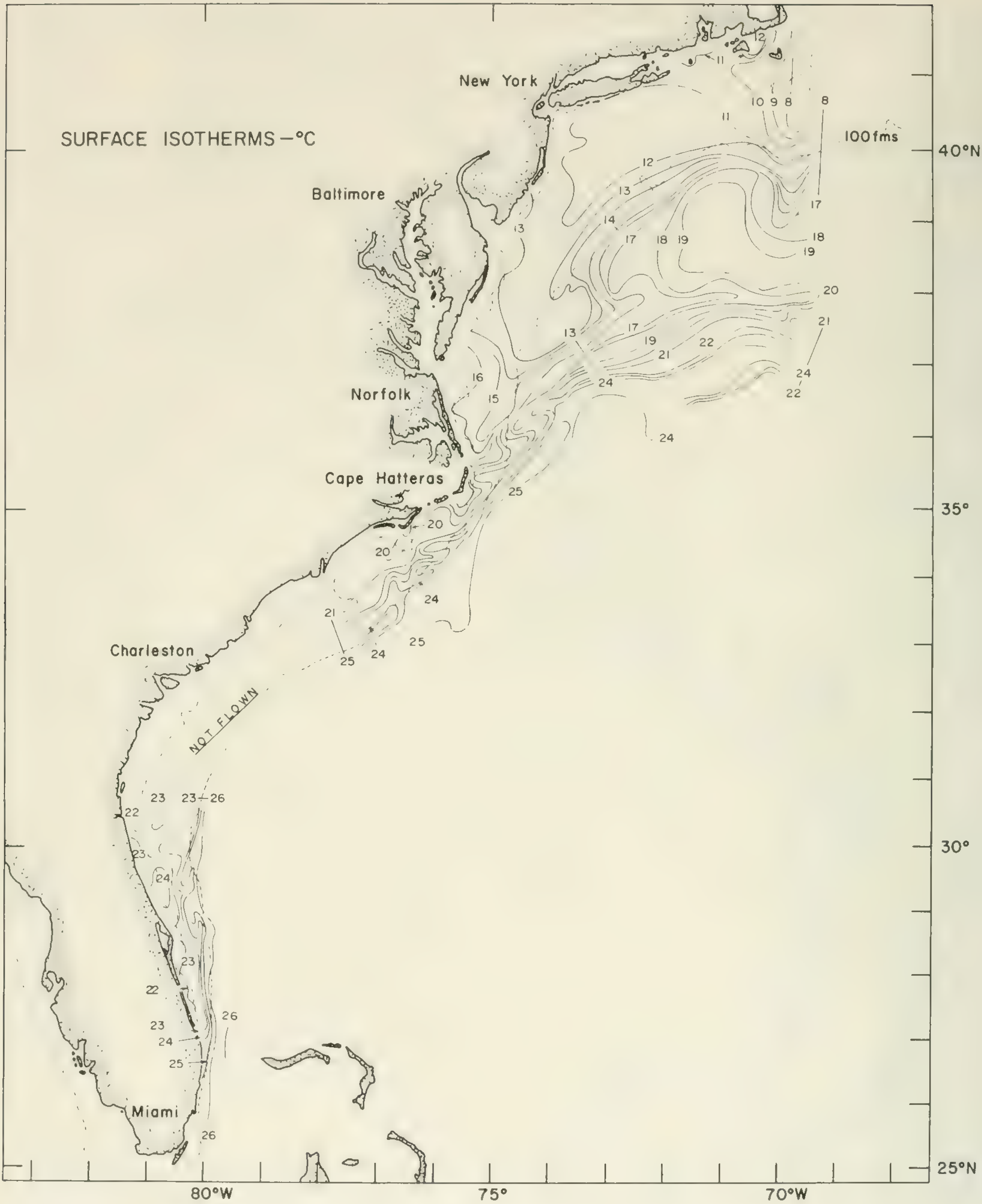

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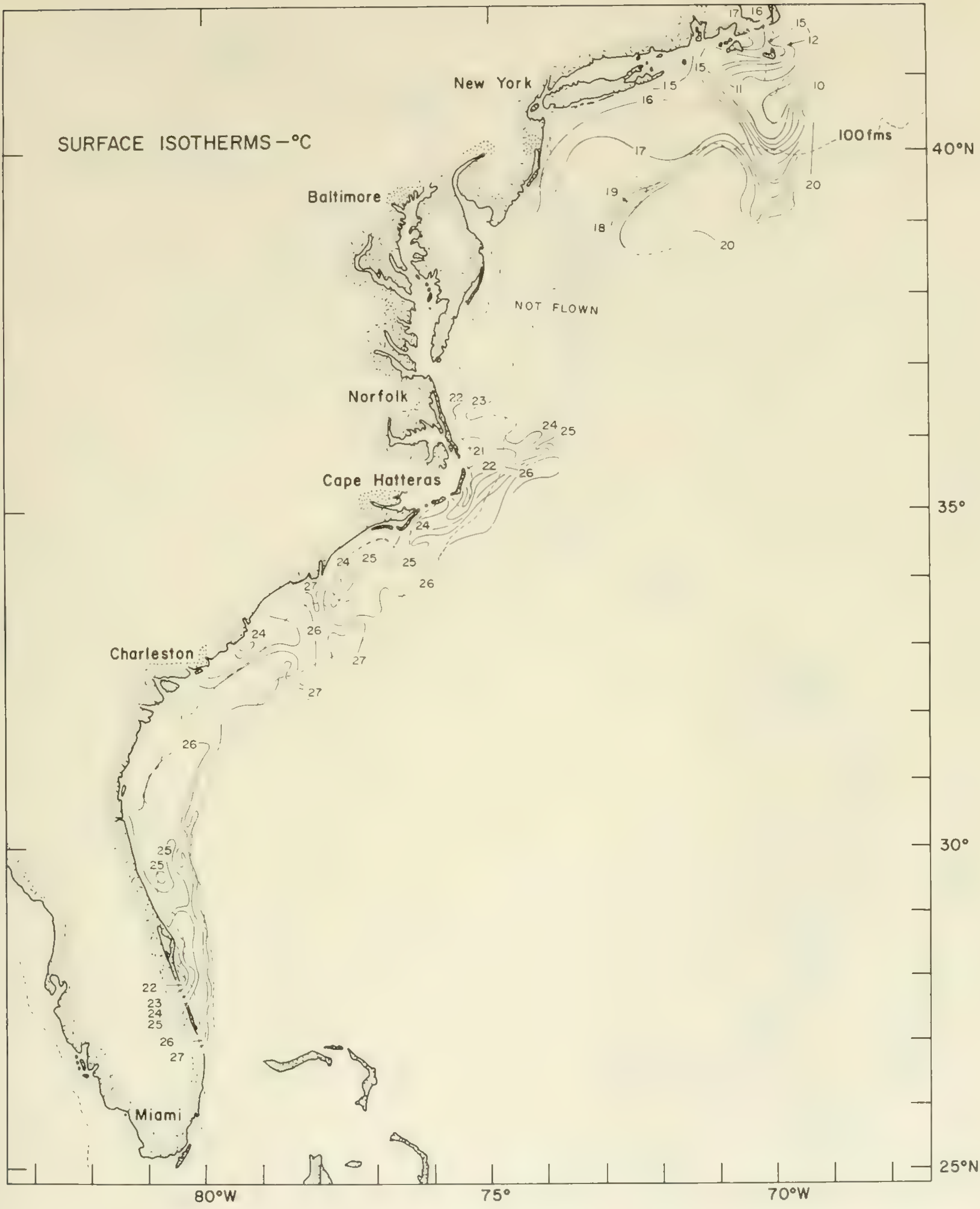

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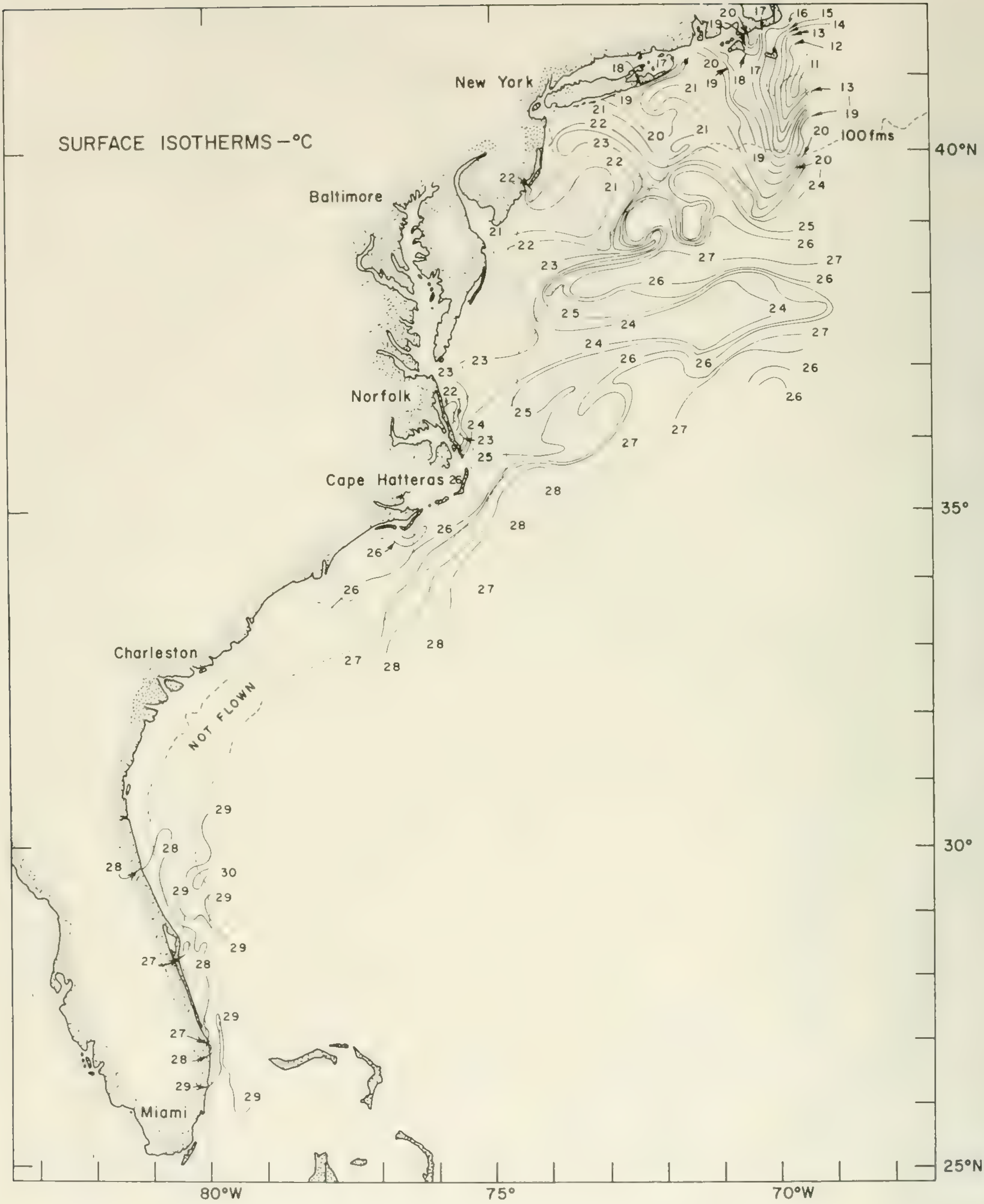

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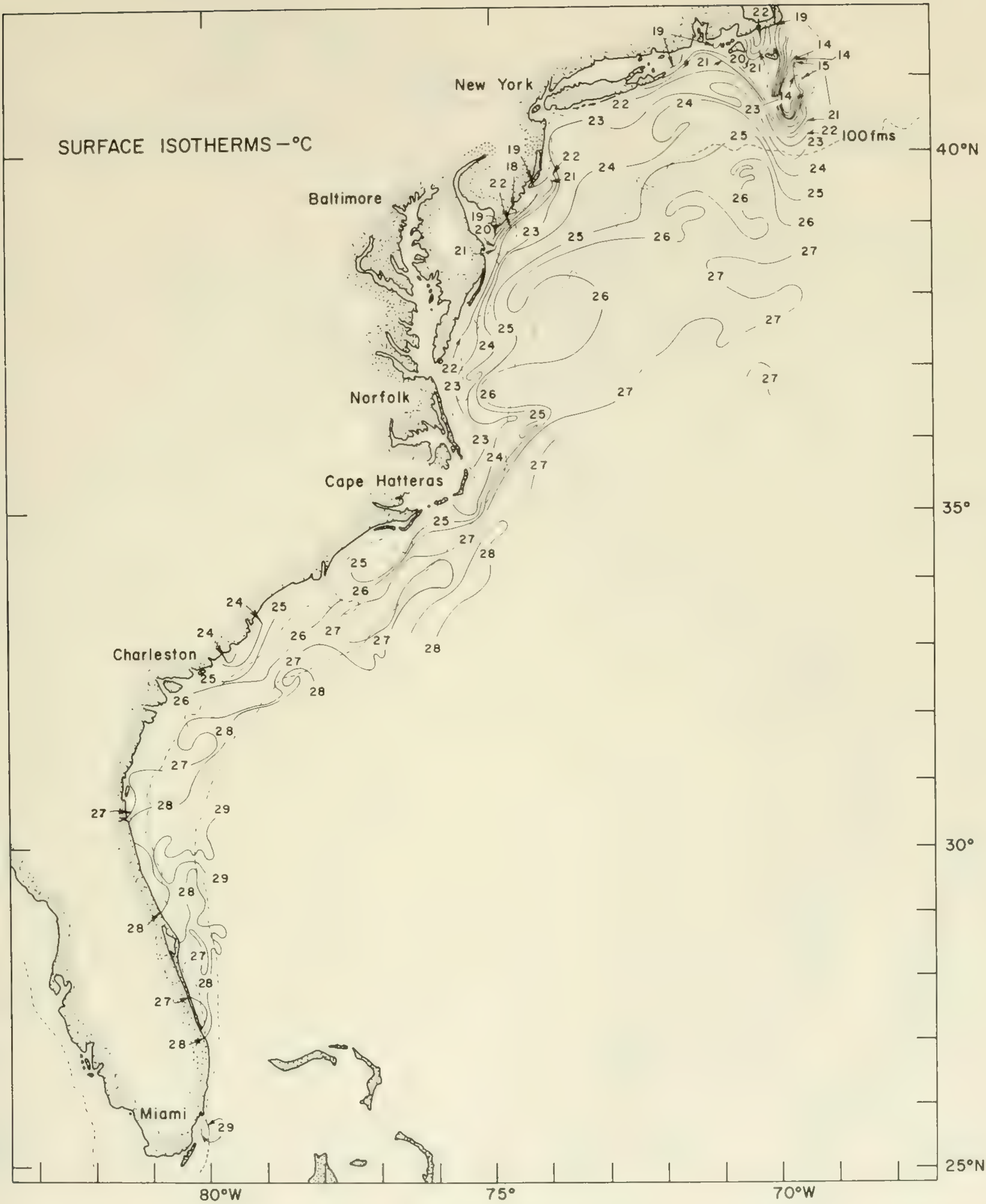

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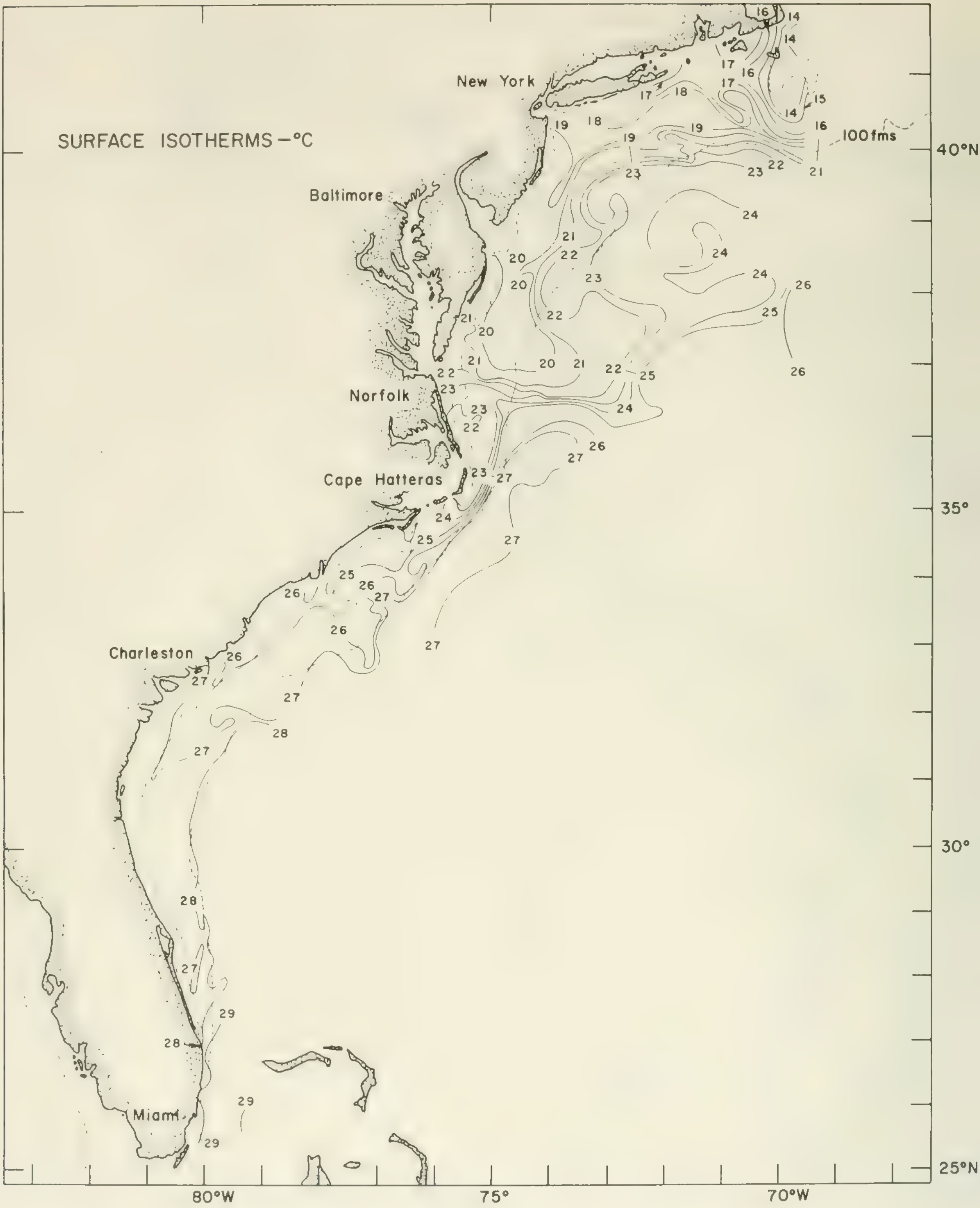

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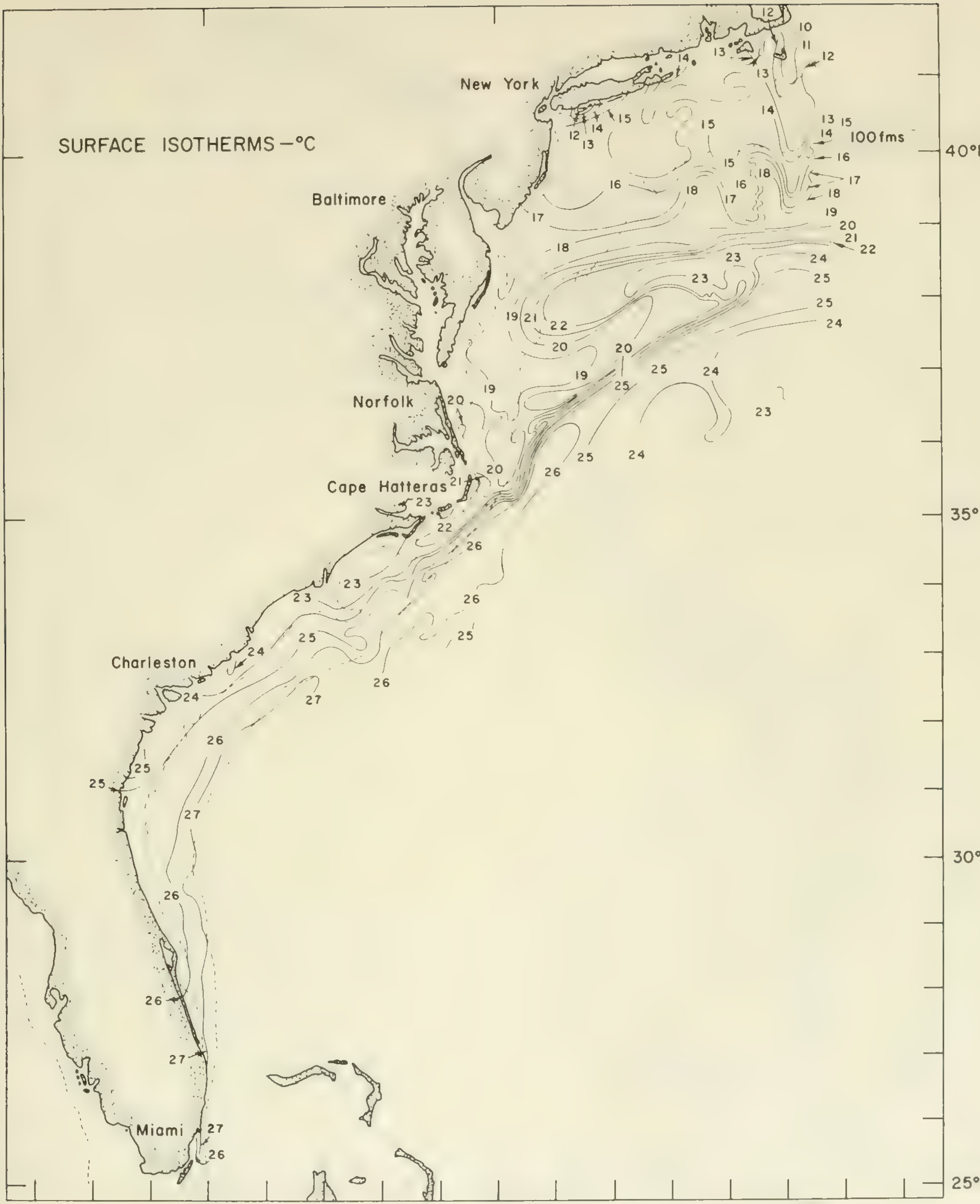

Figure 41. Monthly surface isotherm chart, 15-19 October 1973

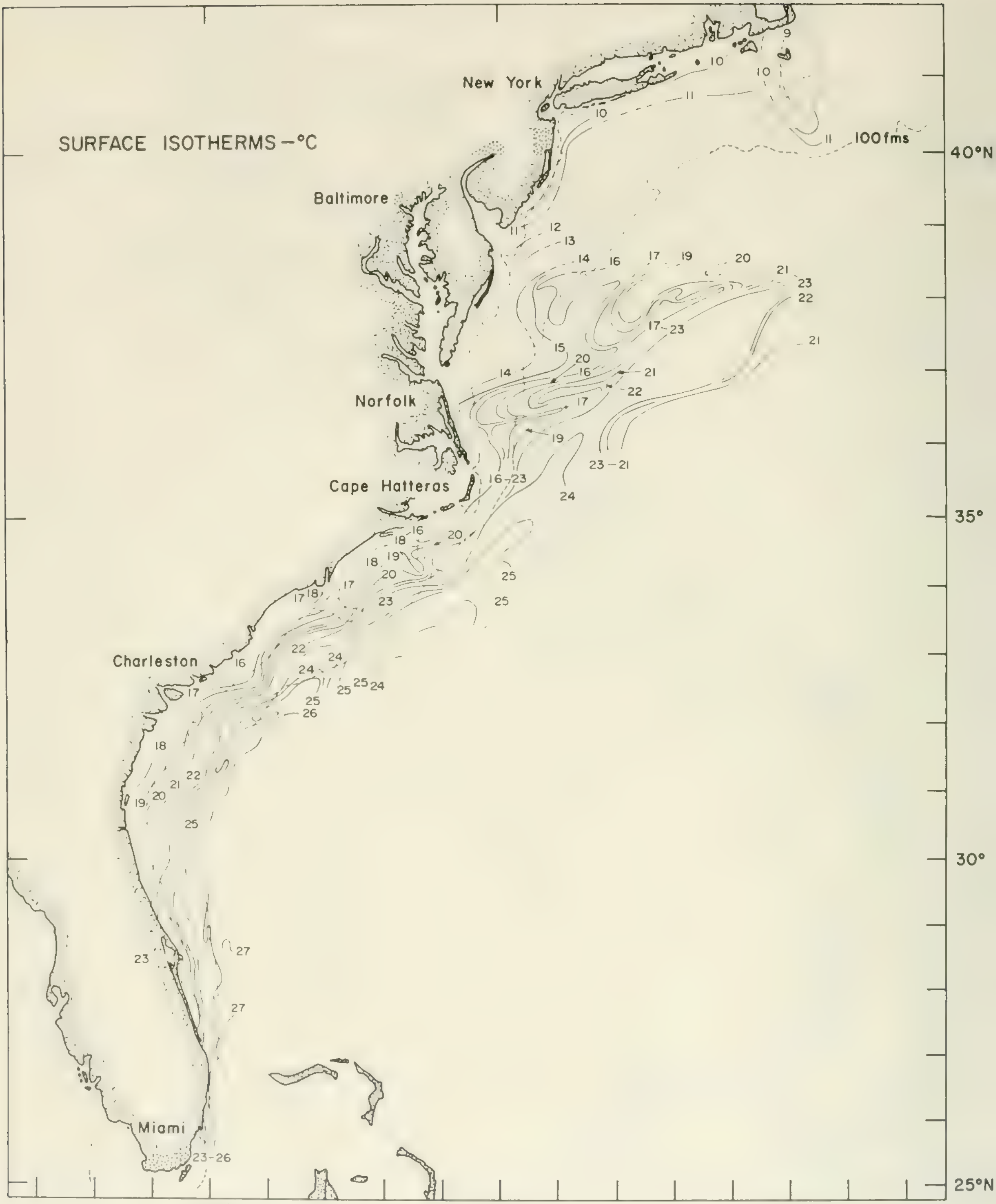

Figure 42. Monthly surface isotherm chart, 12-16 November 1973

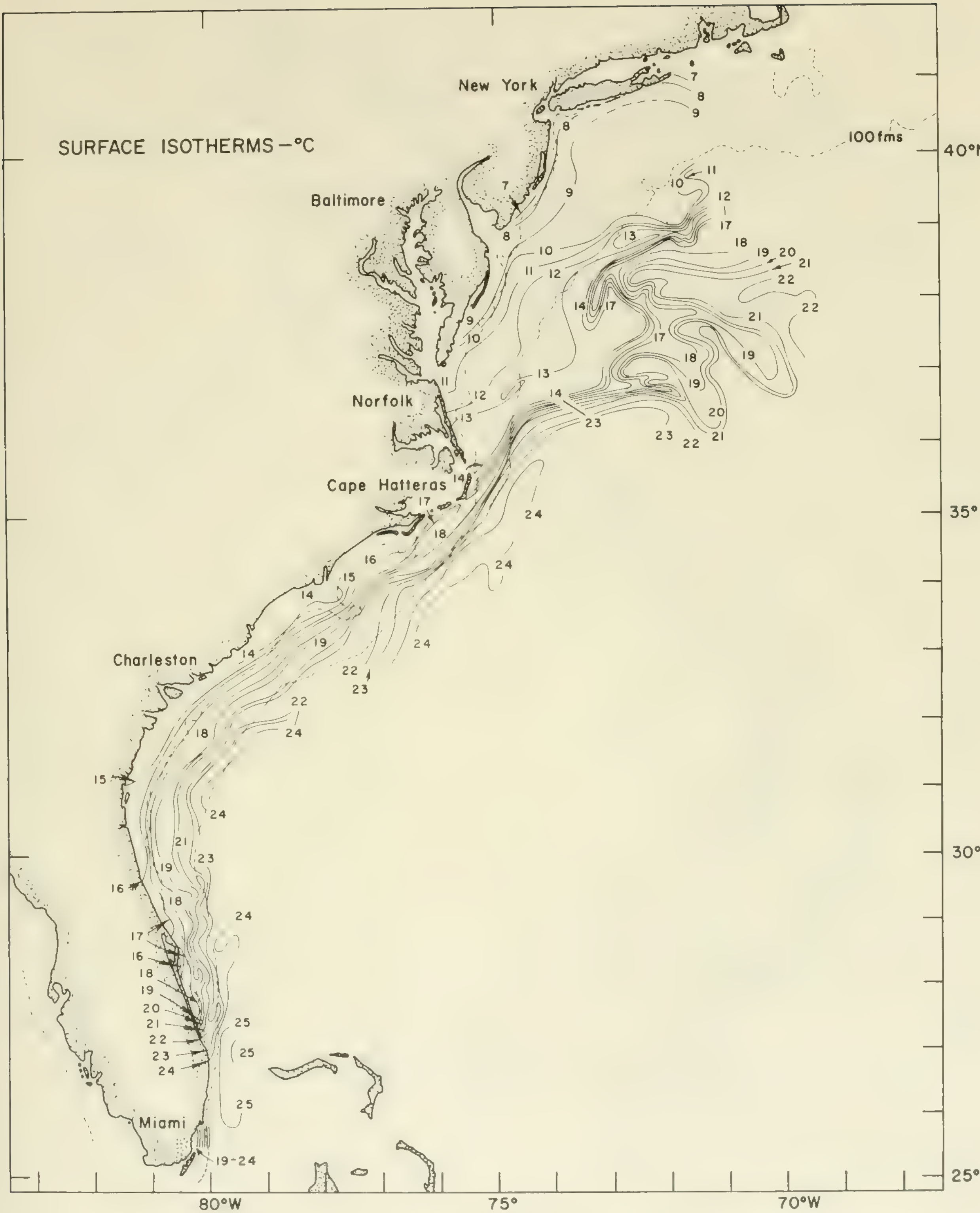

Figure 43. Monthly surface isotherm chart, 10-13 December 1973

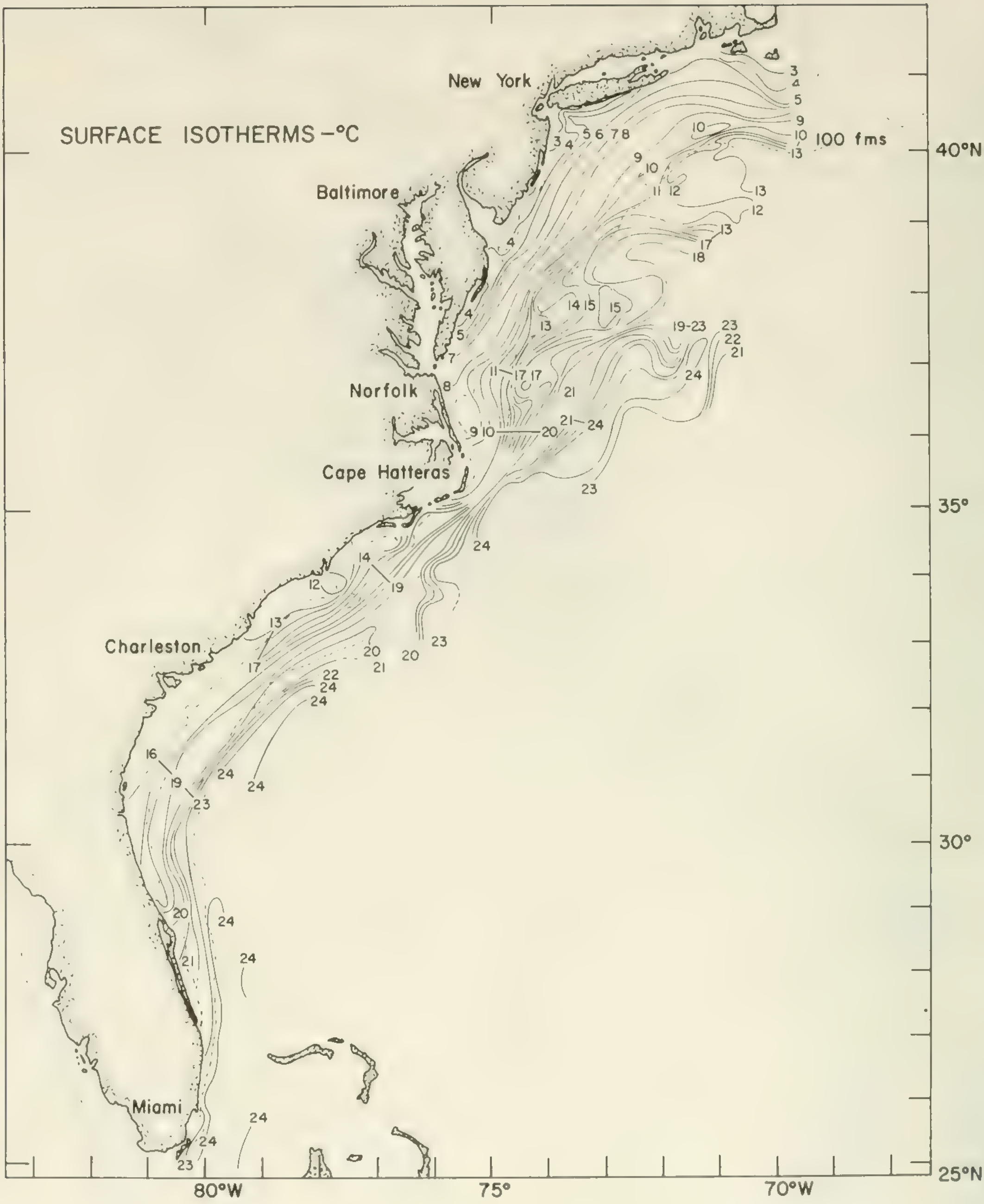

Figure 44. Monthly surface isotherm chart, 14, 16-18, 21 January 1974

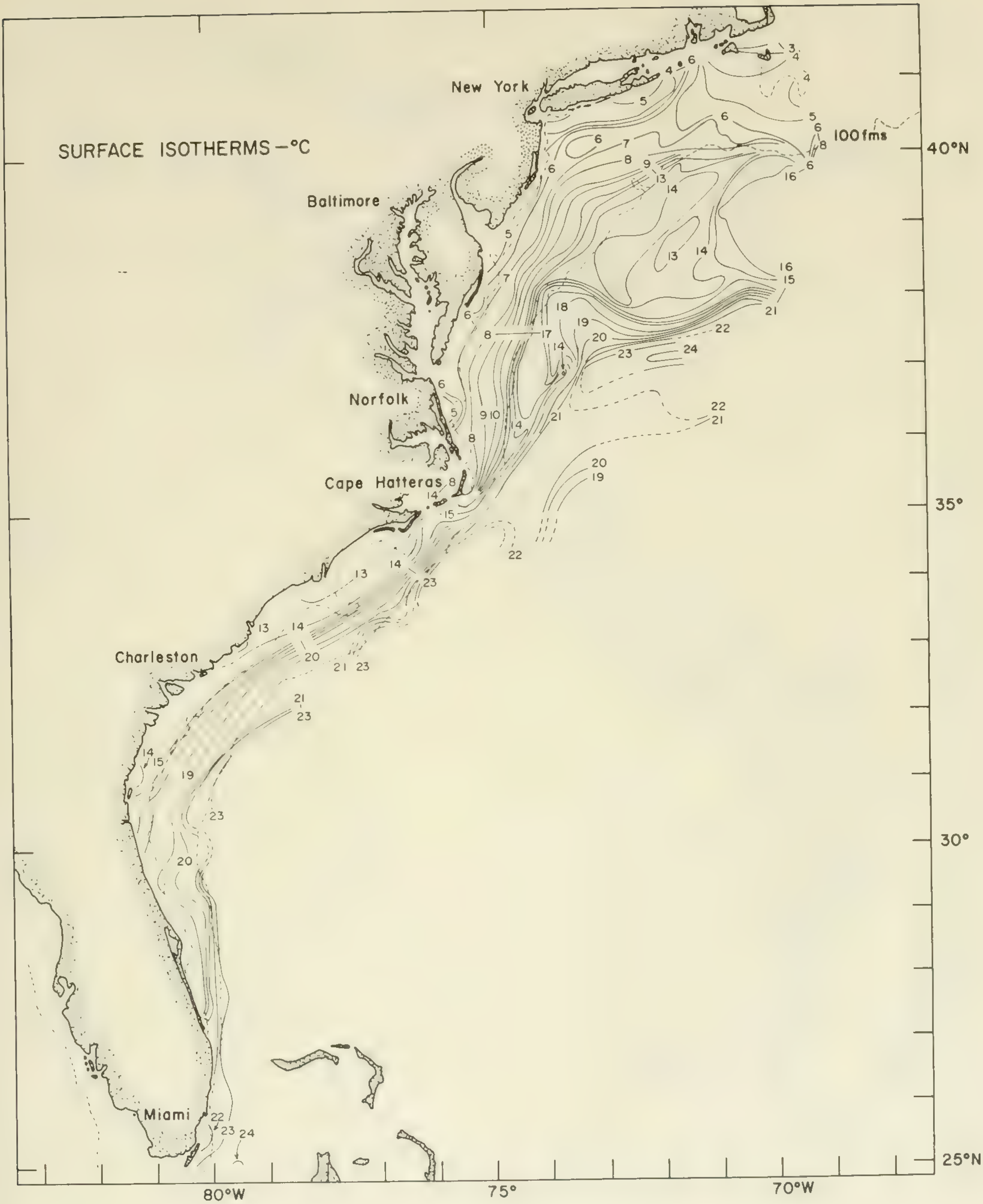

Figure 45. Monthly surface isotherm chart, 12-14 February 1974

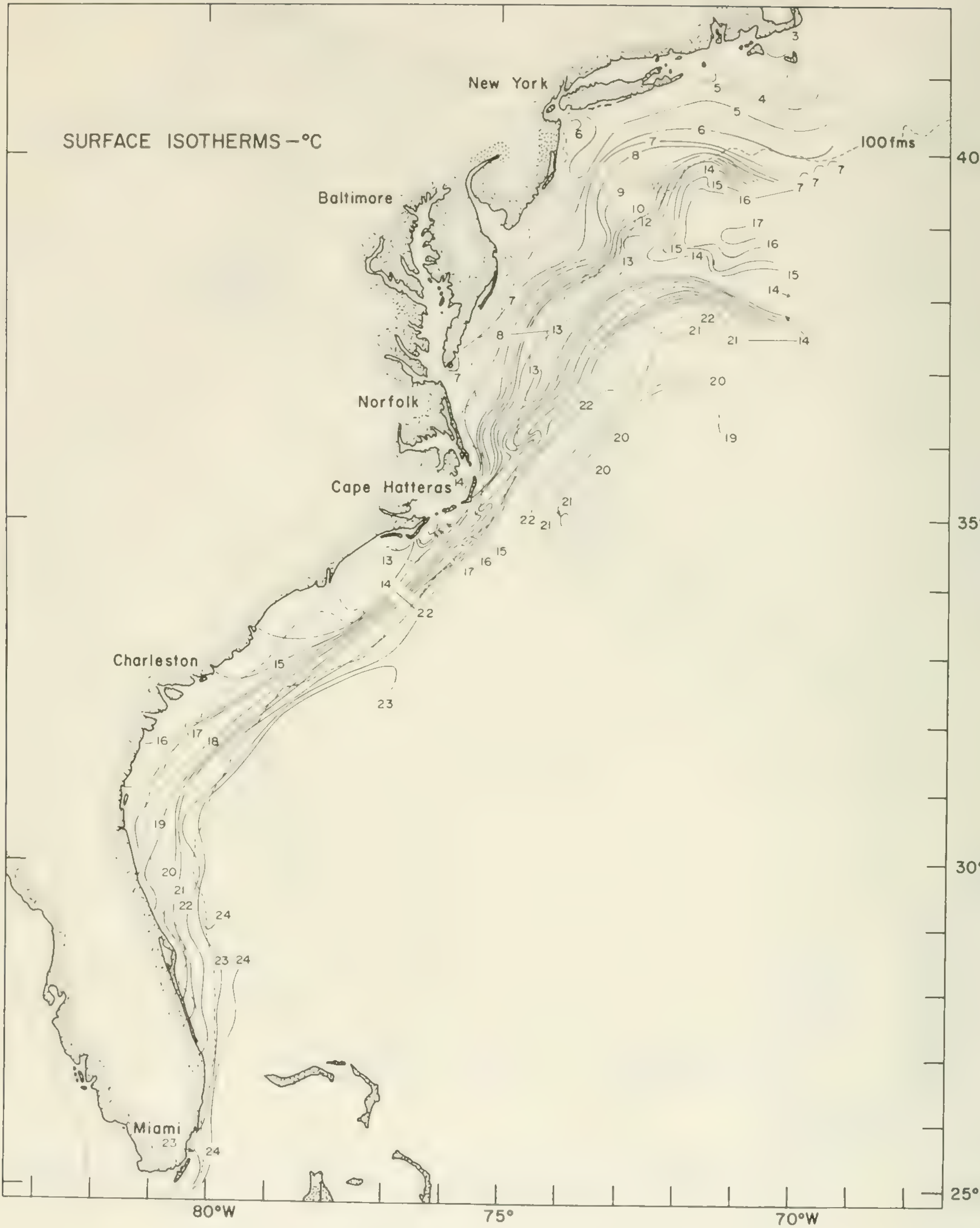

Figure 46. Monthly surface isotherm chart, 19, 20, 22 March 1974

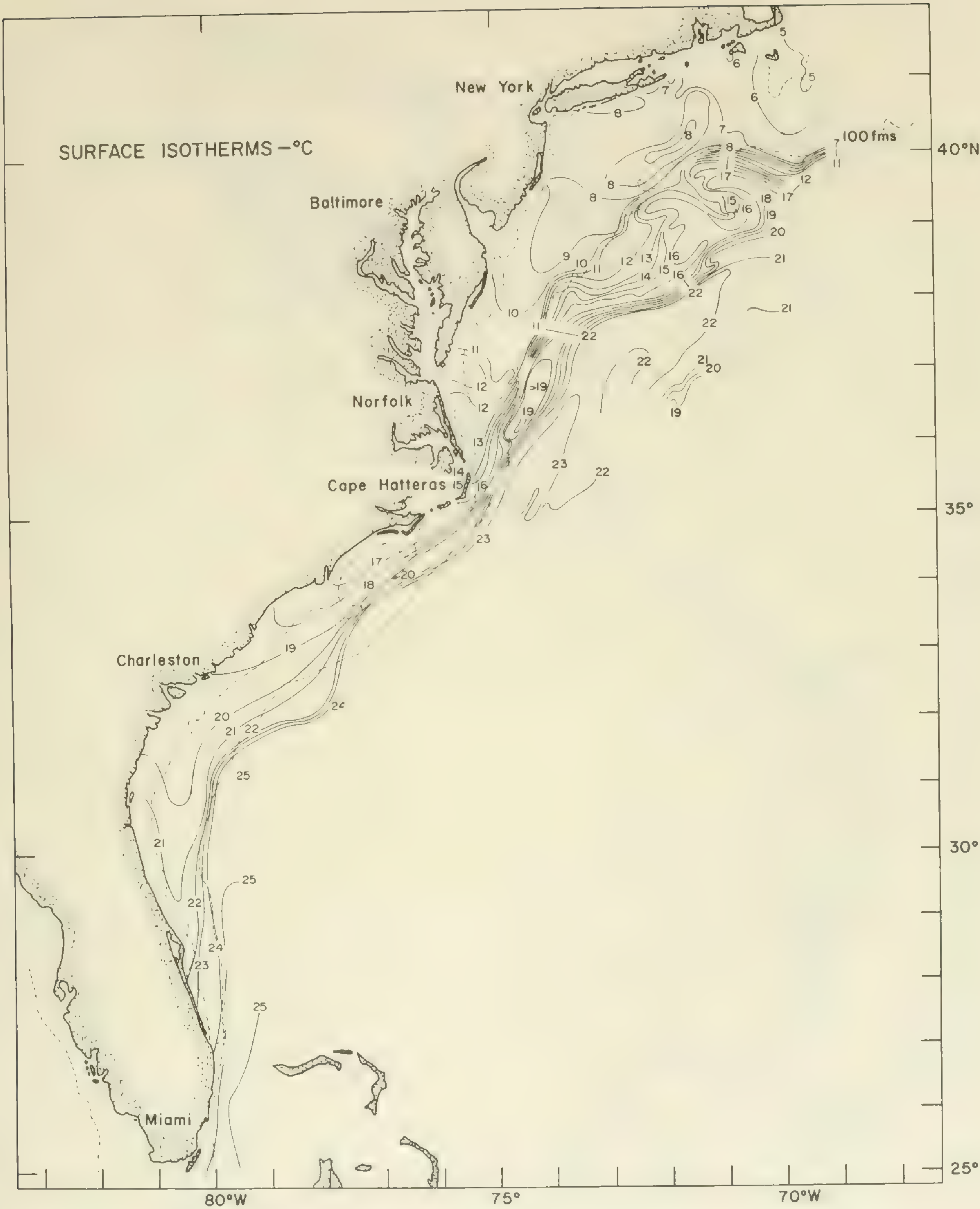

Figure 47. Monthly surface isotherm chart, 22-24, 26 April 1974

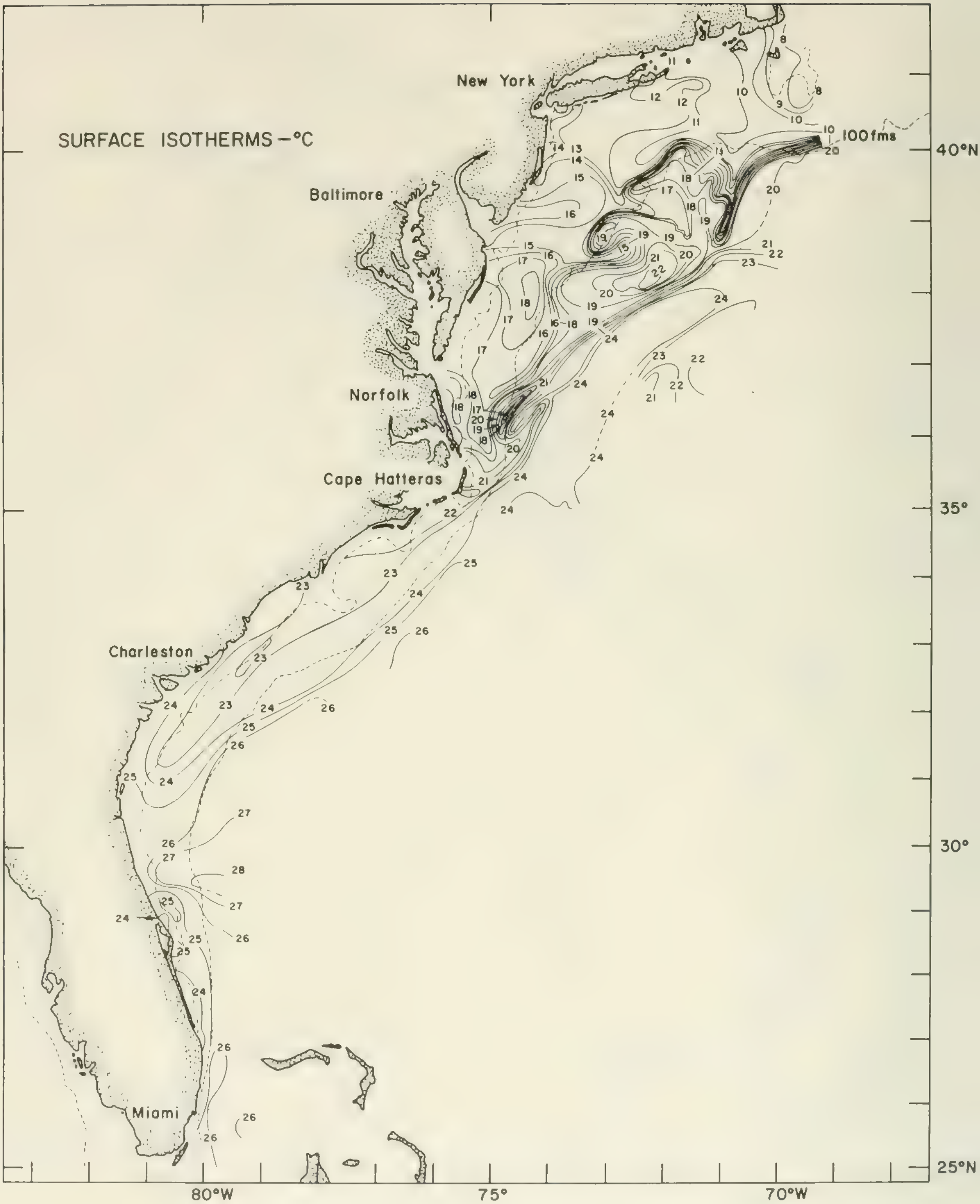

Figure 48. Monthly surface isotherm chart, 20-22 May 1974

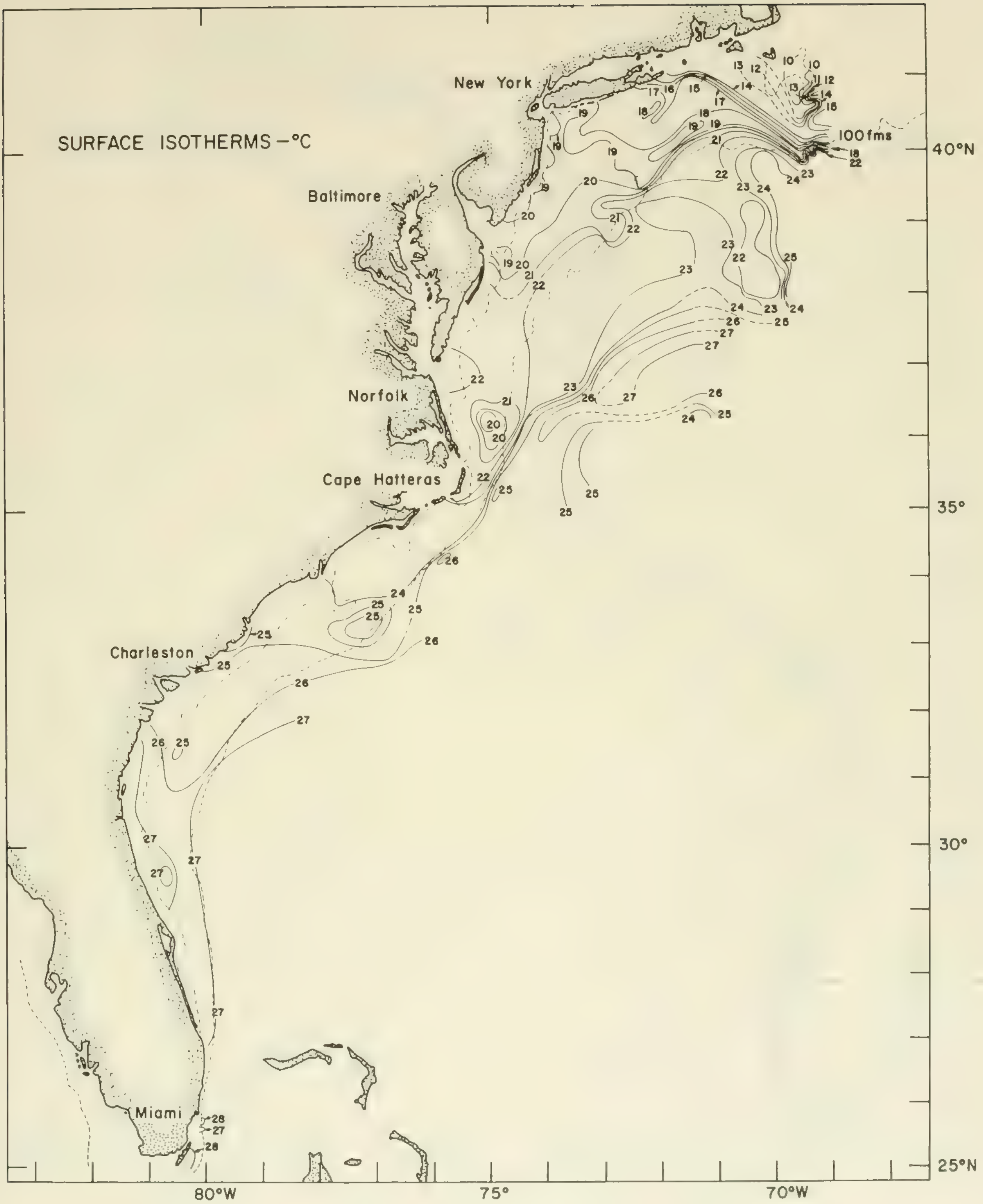

Figure 49. Monthly surface isotherm chart, 19-21 June 1974

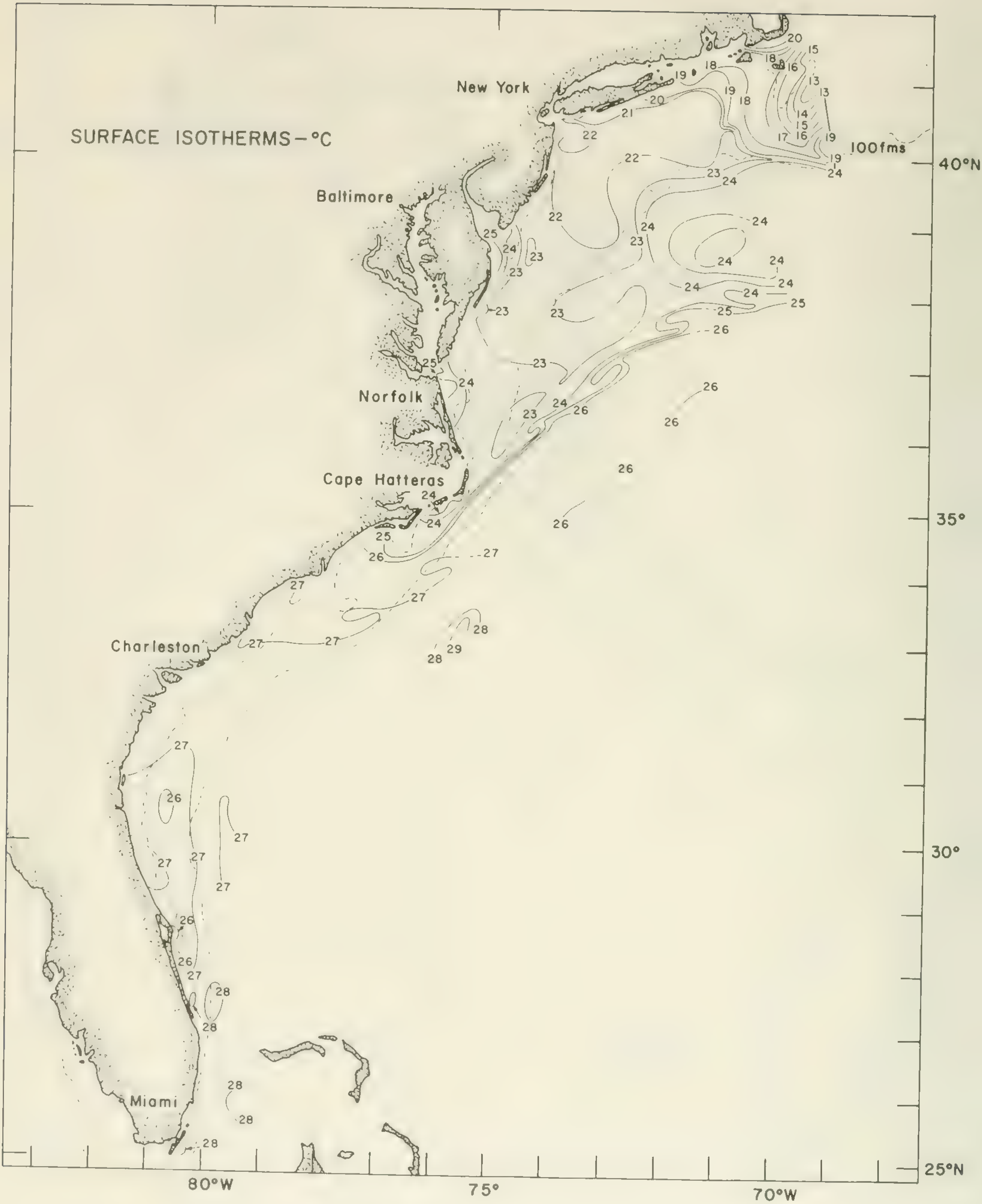

Figure 50. Monthly surface isotherm chart, 15-17 July 1974

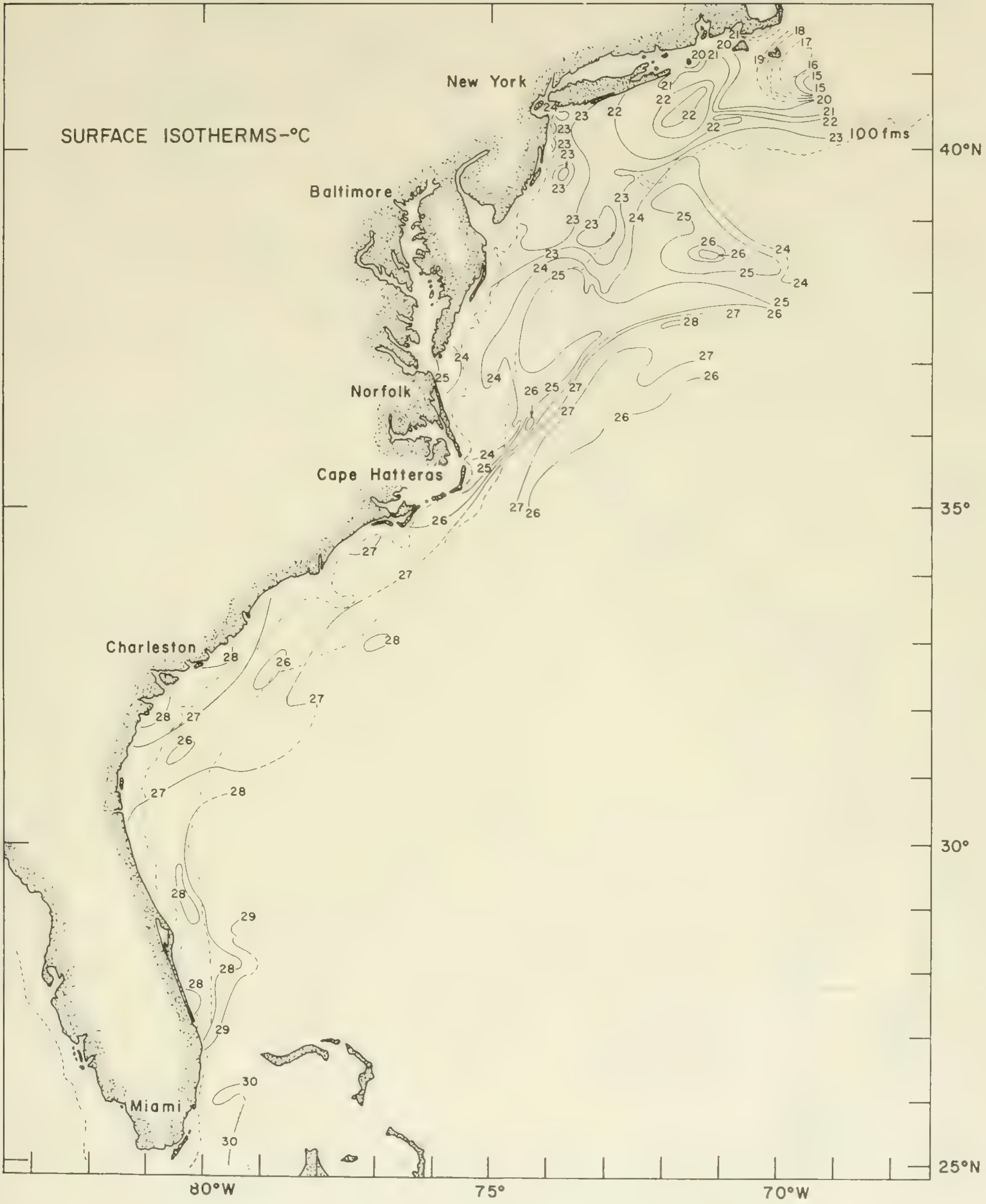

Figure 51. Monthly surface isotherm chart, 19-22 August 1974

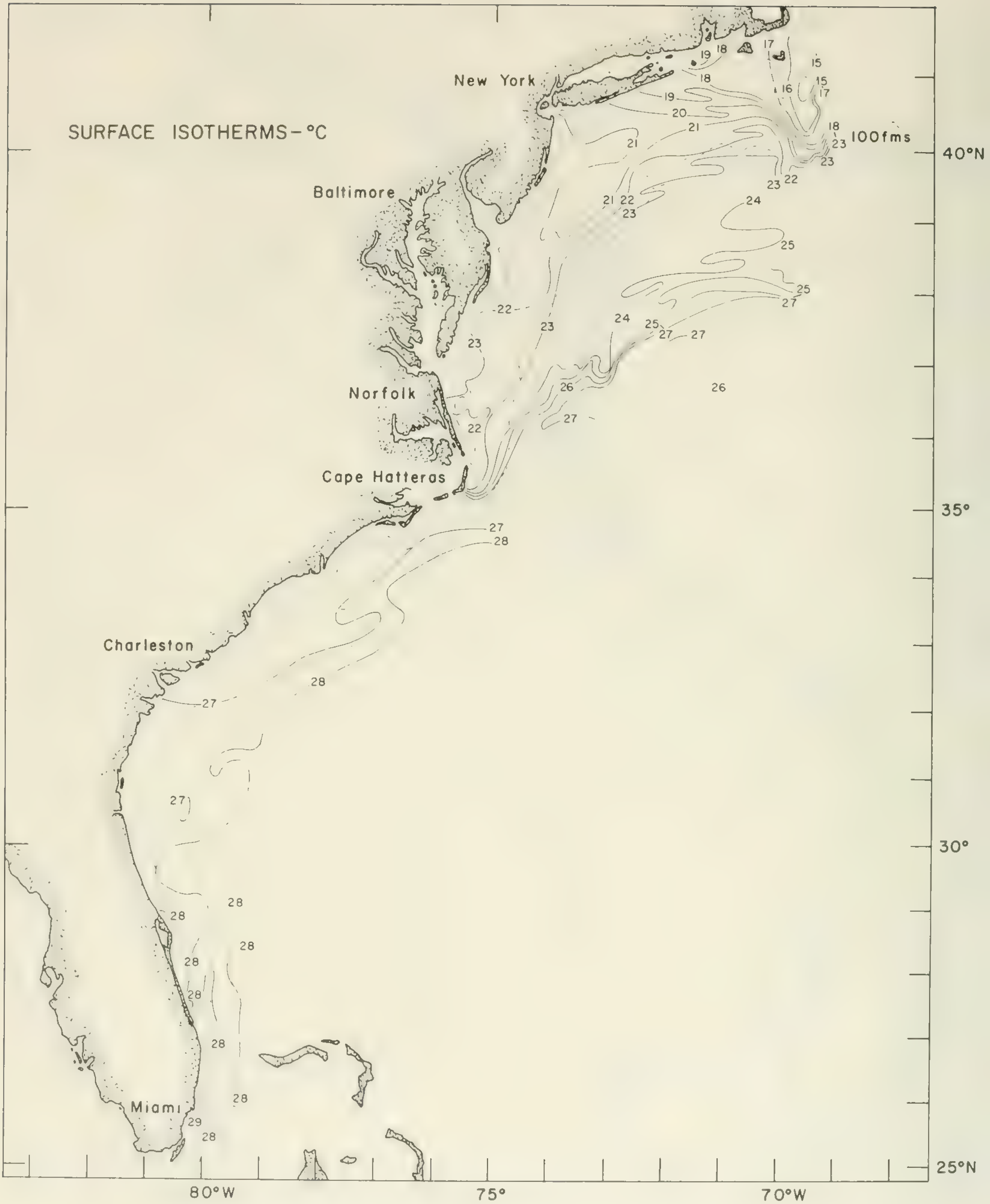

Figure 52. Monthly surface isotherm chart, 16-20, 23 September 1974

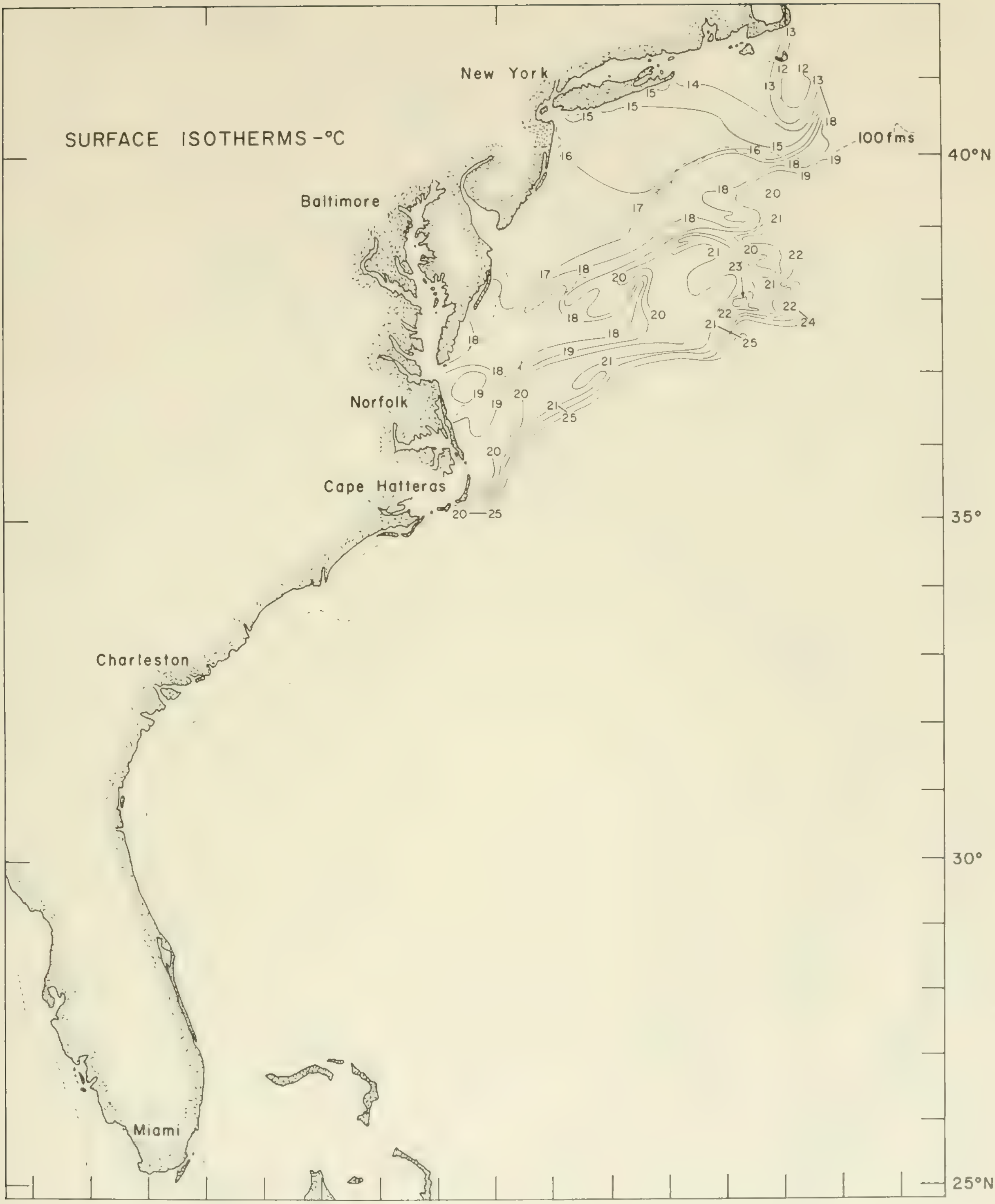

Figure 53. Monthly surface isotherm chart, 15, 17, 18 October 1974

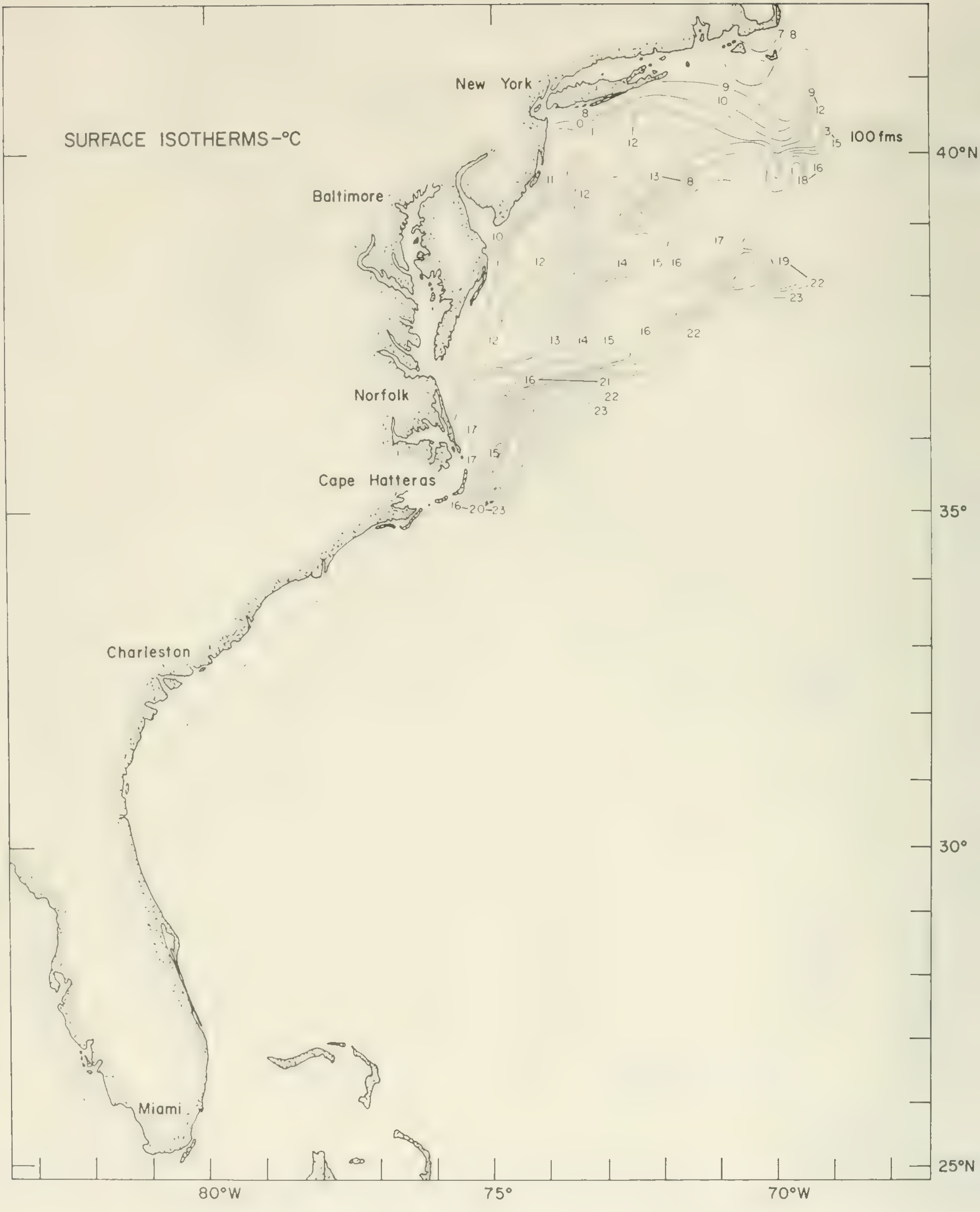

Figure 54. Monthly surface isotherm chart, 19, 22, 23 November 1974

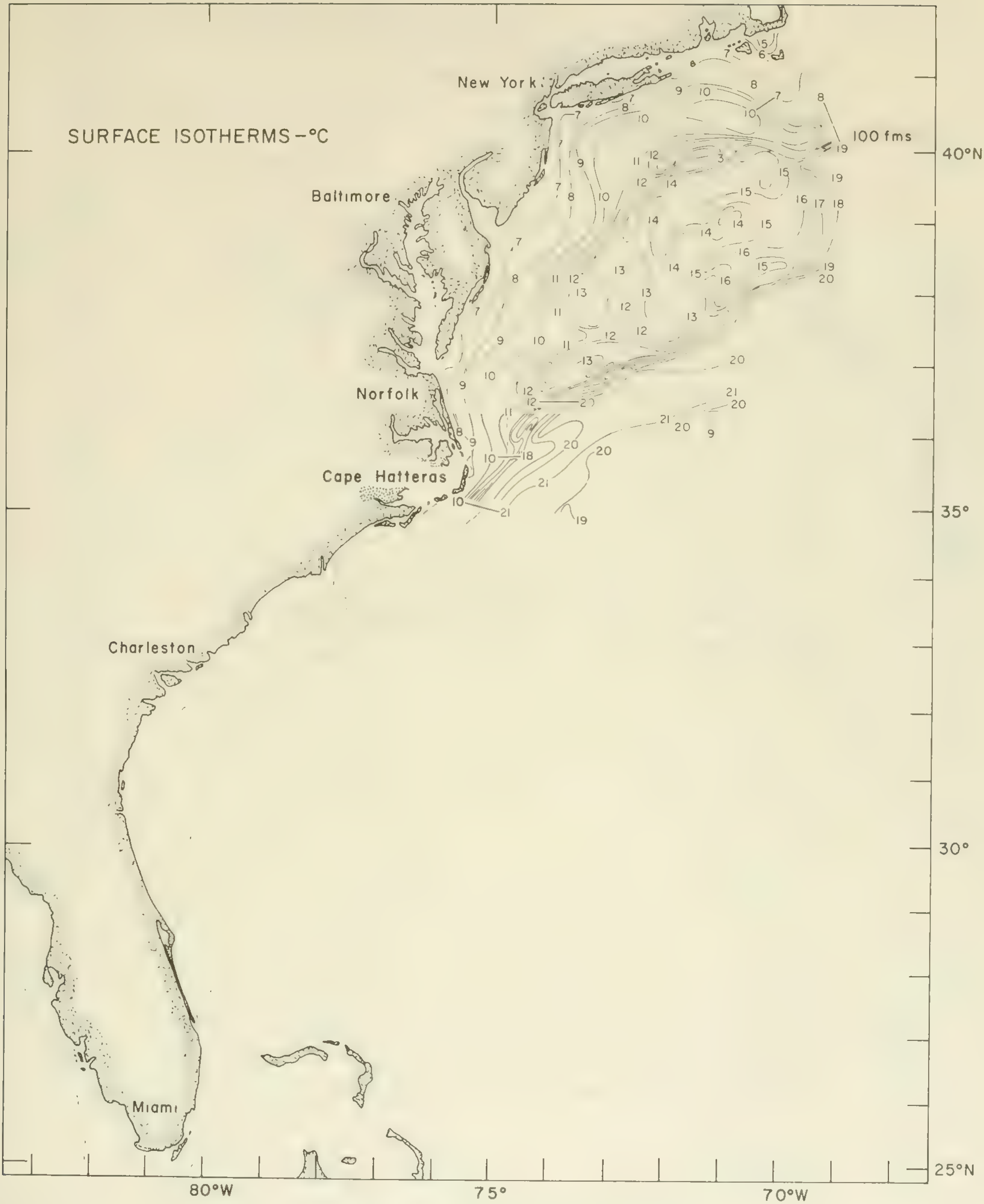

Figure 55. Monthly surface isotherm chart, 10-12 December 1974

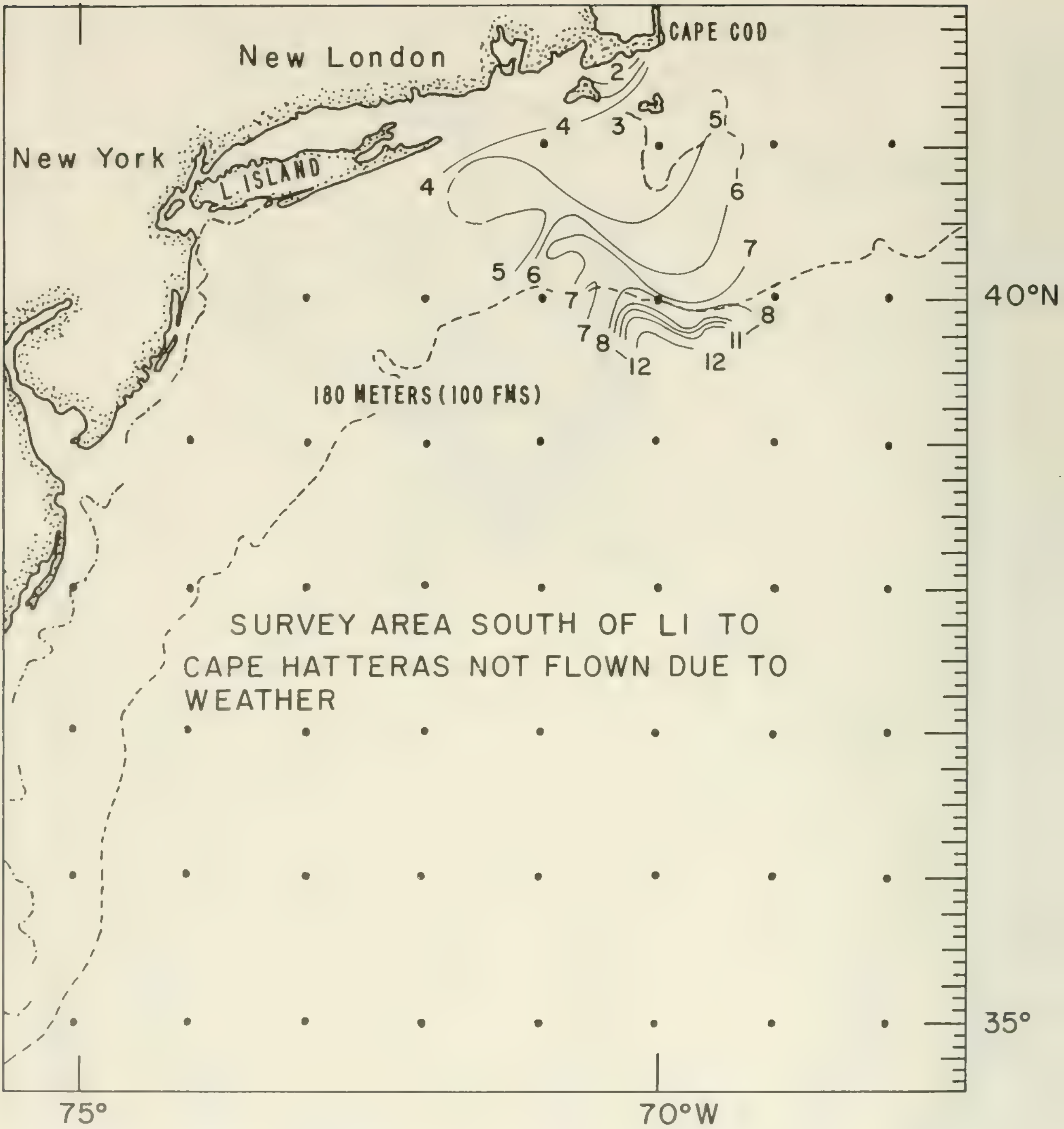

Figure 56. Monthly surface isotherm chart, 1 February 1975

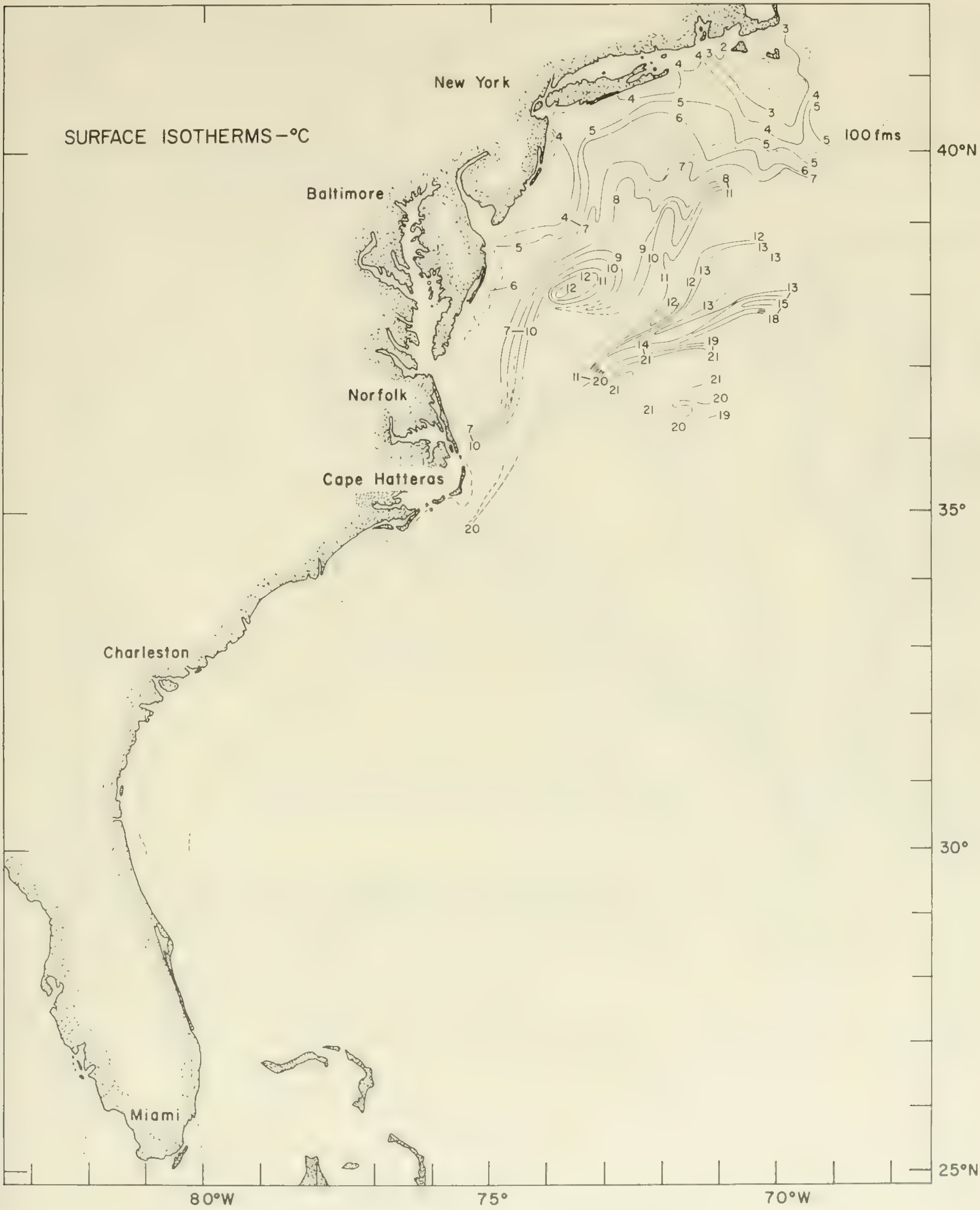

Figure 57. Monthly surface isotherm chart, 27, 28 February 1975

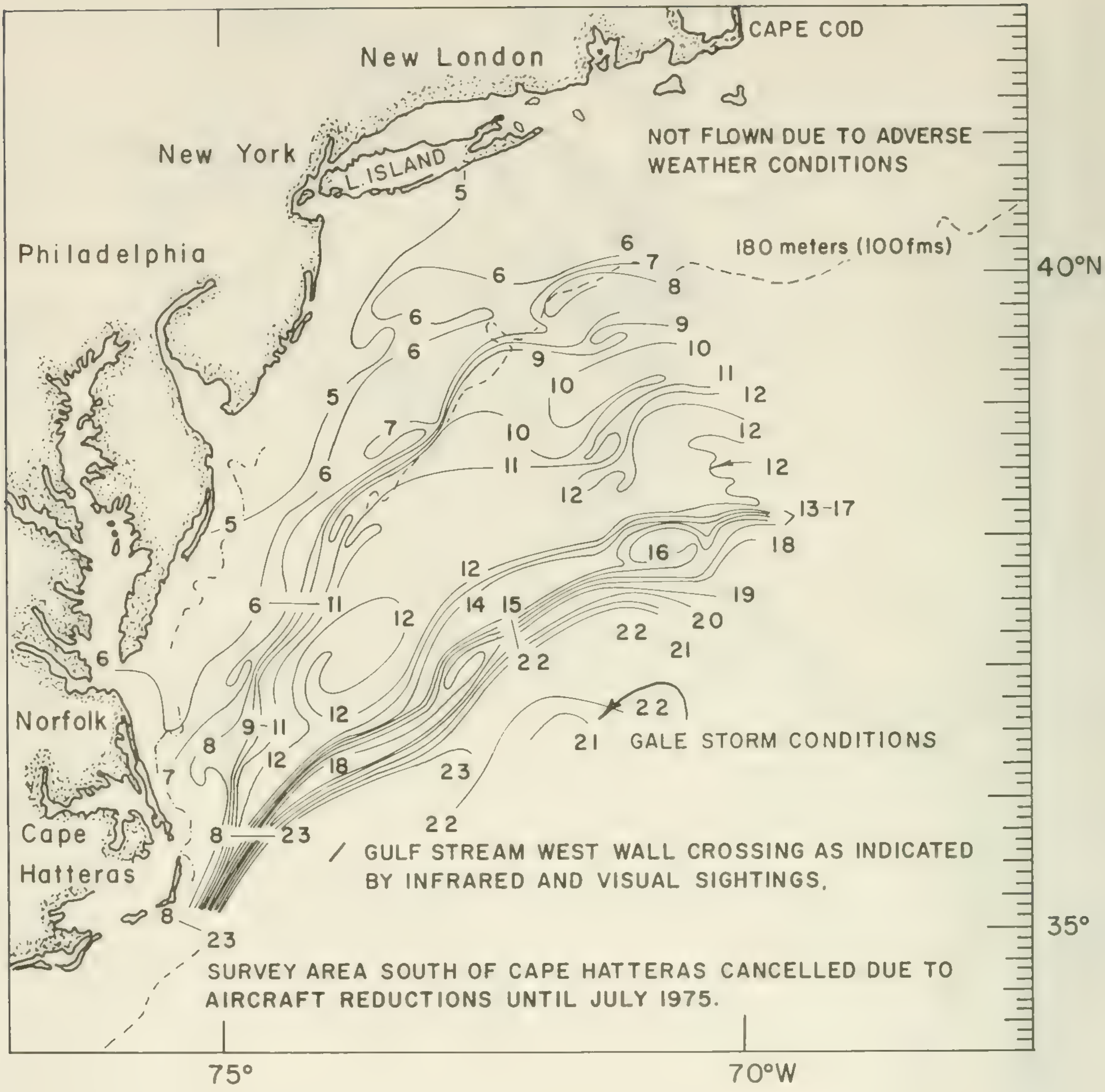
CAPE COD
New London
New York
L. ISLAND
NOT FLOWN DUE TO ADVERSE WEATHER CONDITIONS
180 meters (100fms)
40°N
Philadelphia
5
6
7
8
6
6
6
9
9
10
10
11
12
12
12
12
5
7
10
11
6
13-17
16
18
5
12
6
11
12
14
15
19
20
22
21
22
6
22
12
Norfolk
9-11
8
12
18
21
GALE STORM CONDITIONS
7
23
Cape
Hatteras
8
23
22
GULF STREAM WEST WALL CROSSING AS INDICATED BY INFRARED AND VISUAL SIGHTINGS.
8
23
35°
SURVEY AREA SOUTH OF CAPE HATTERAS CANCELLED DUE TO AIRCRAFT REDUCTIONS UNTIL JULY 1975.
75°
70°W

Figure 58. Monthly surface isotherm chart, 18, 20 March 1975

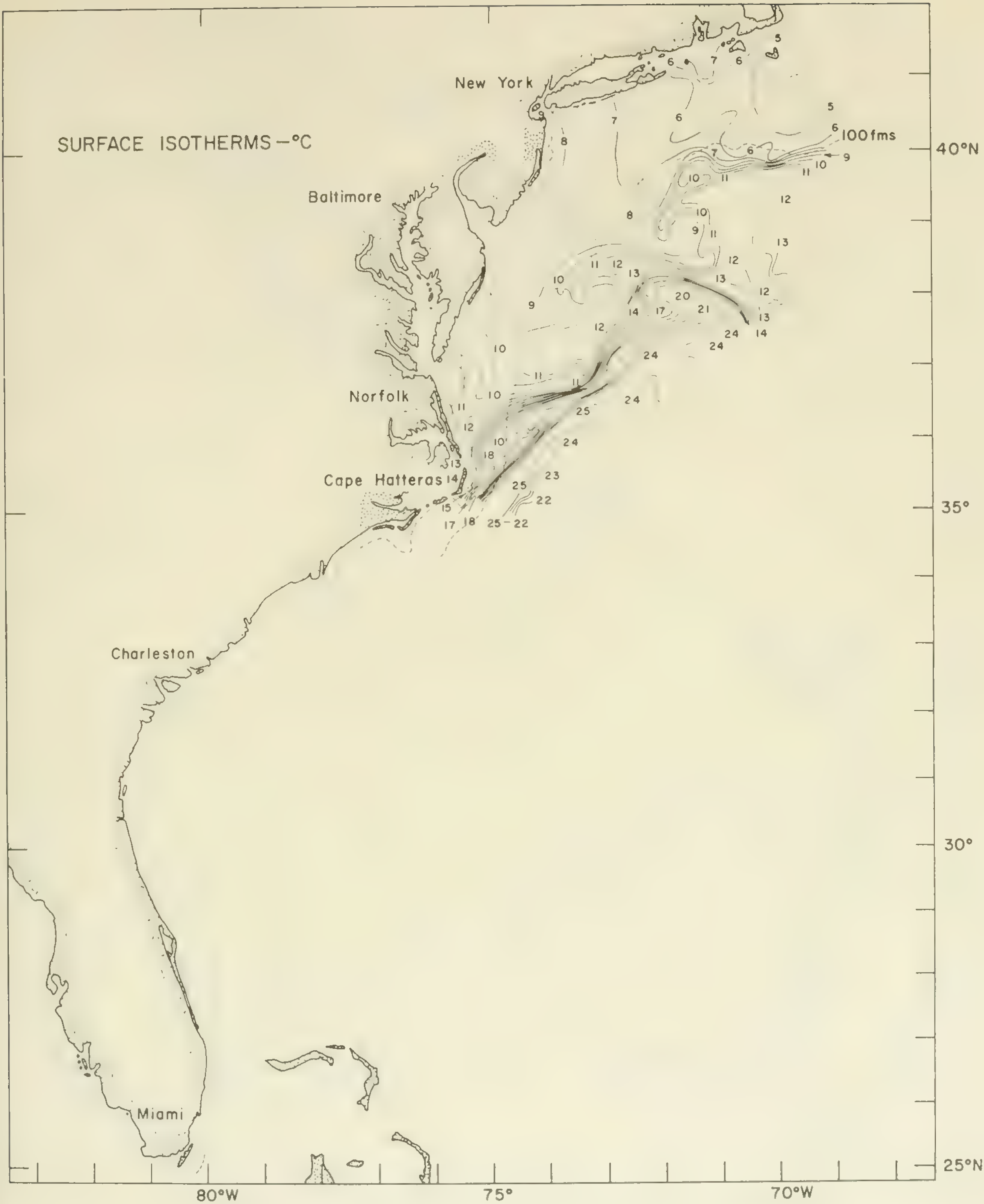

Figure 59. Monthly surface isotherm chart, 29, 30 April—2 May 1975

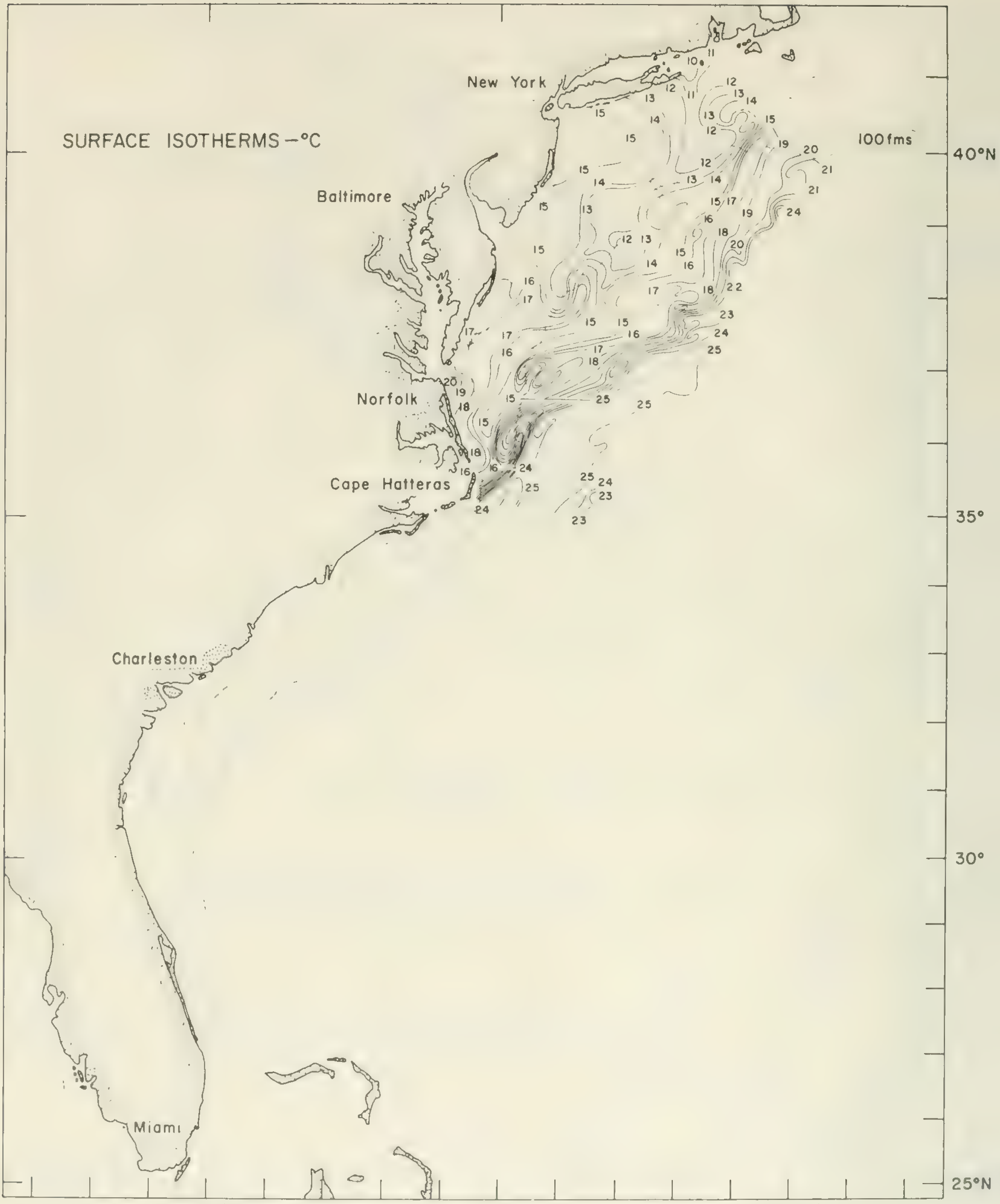

Figure 60. Monthly surface isotherm chart, 20-22 May 1975

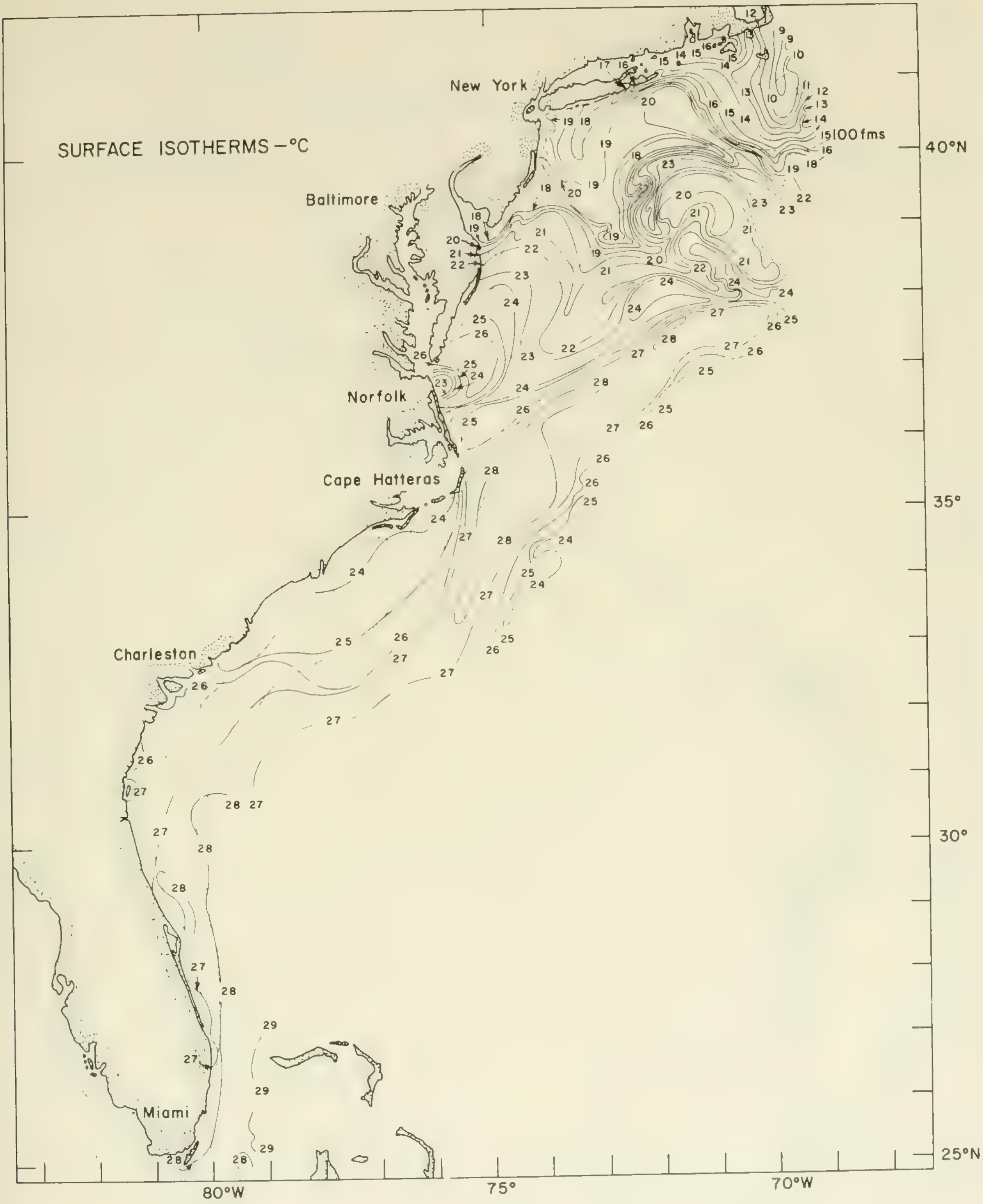

Figure 61. Monthly surface isotherm chart, 10-12, 18-20 June 1975

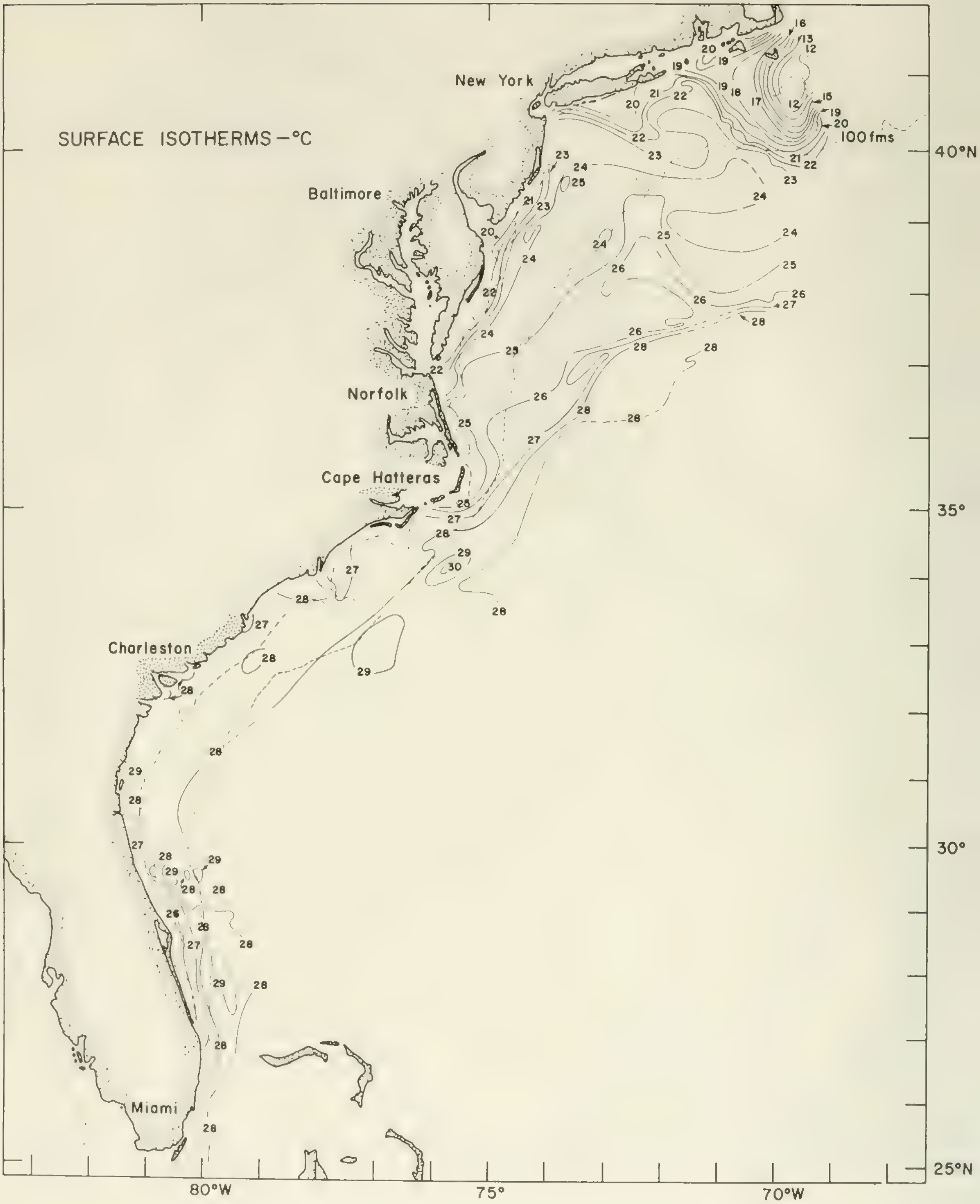

Figure 62. Monthly surface isotherm chart, 22, 24, 25, 29-31 July 1975

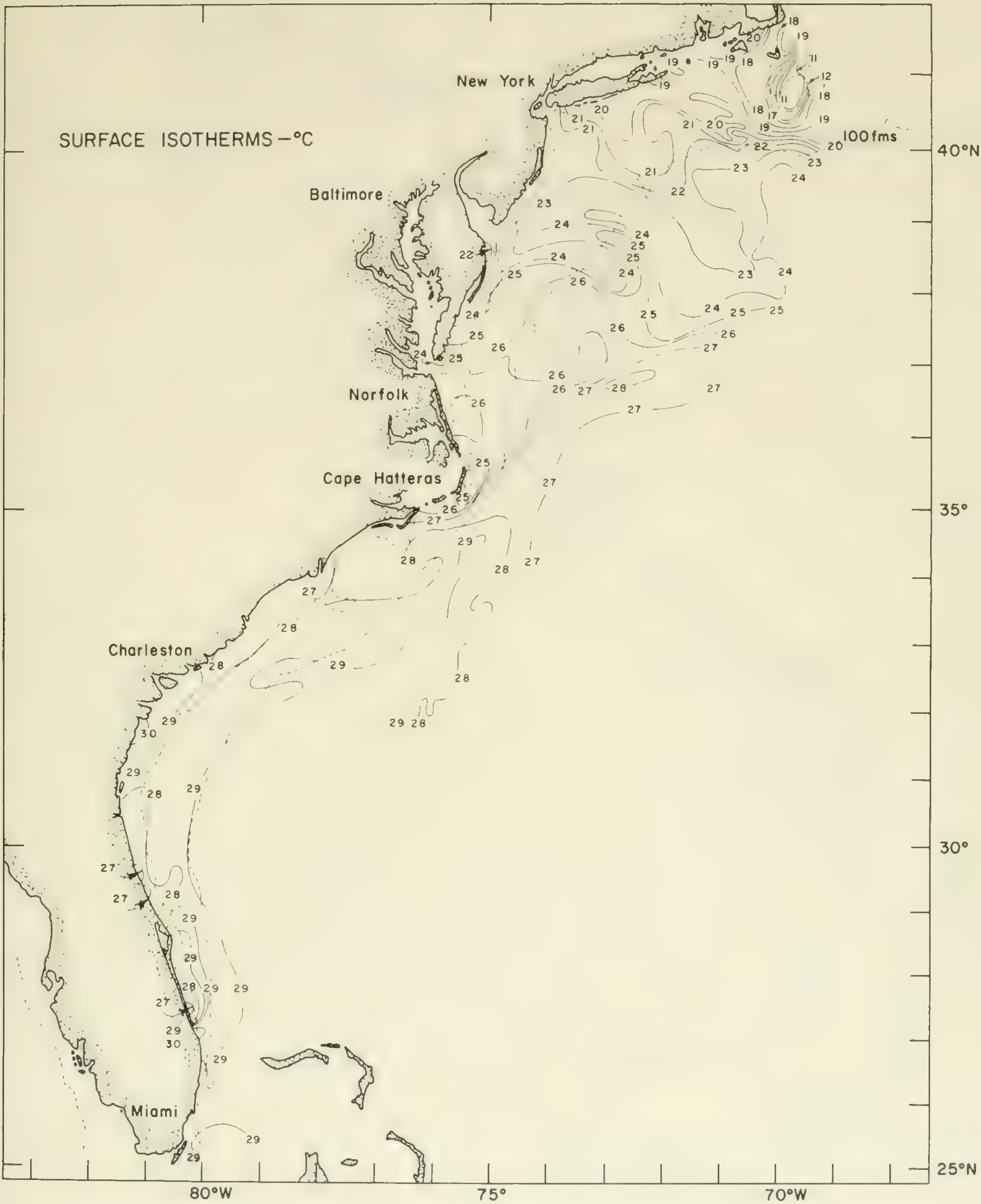

Figure 63. Monthly surface isotherm chart, 19-21 August 1975

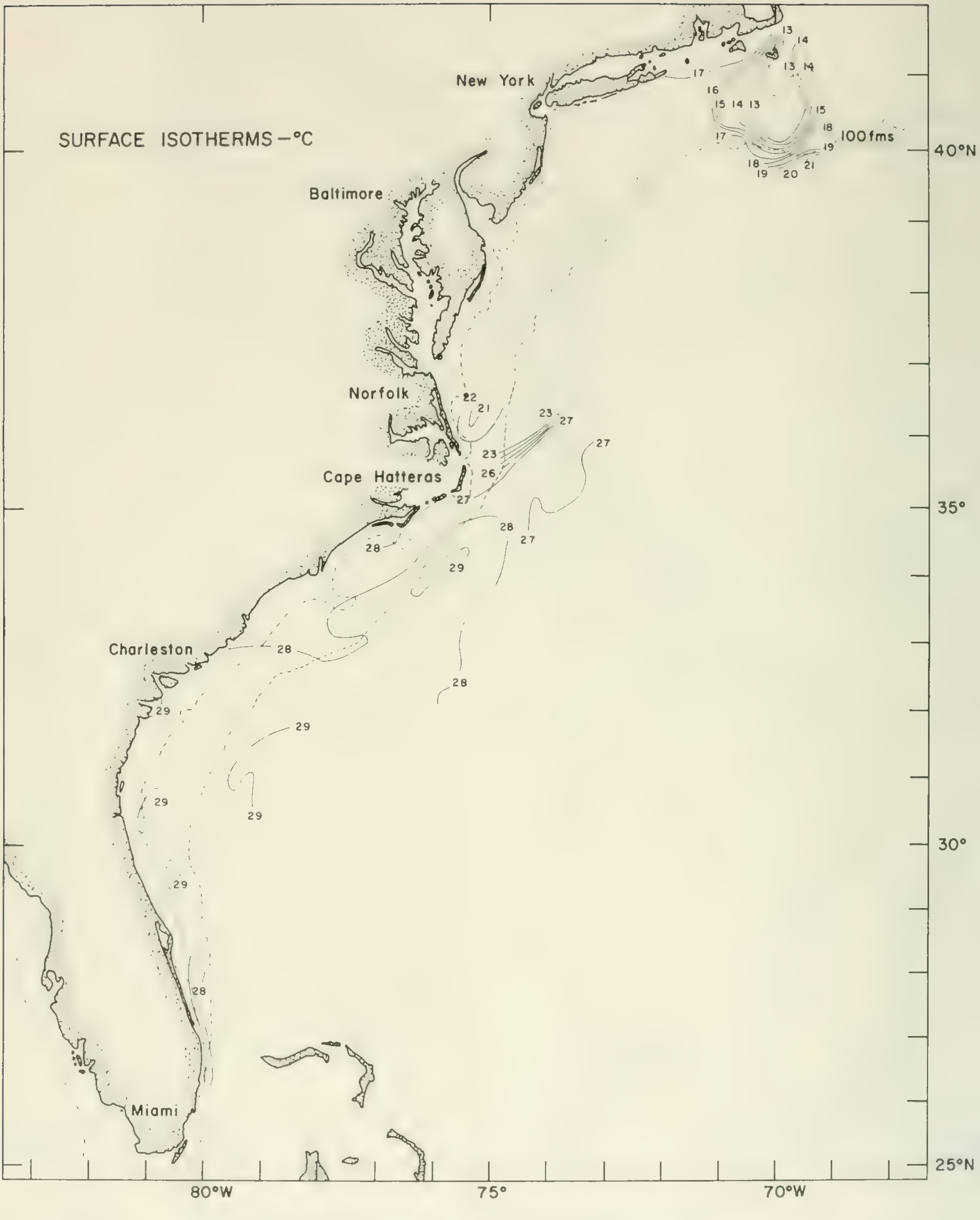

Figure 64. Monthly surface isotherm chart, 9-11, 16-18 September 1975

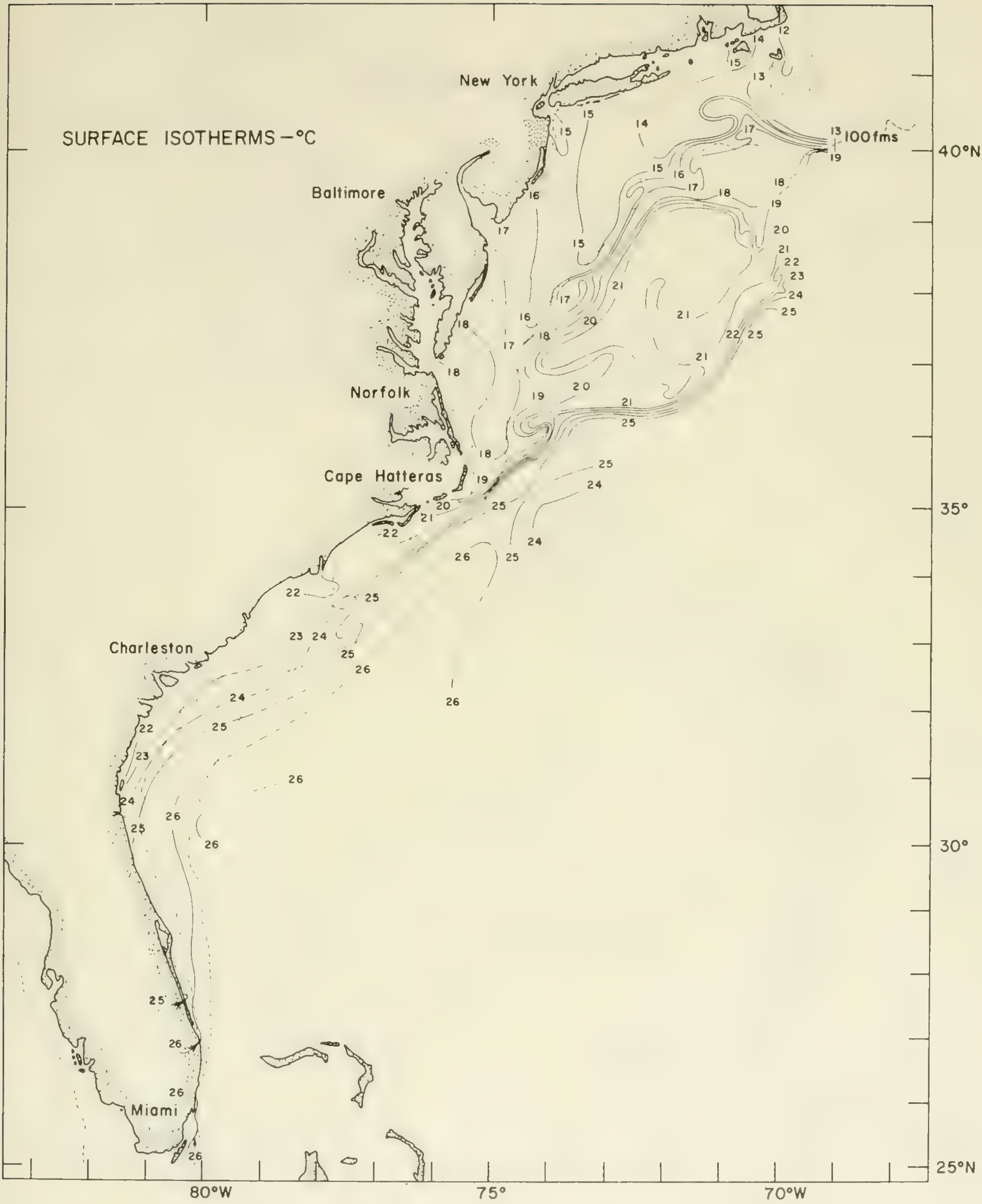

Figure 65 Monthly surface isotherm chart, 21-25 October 1975

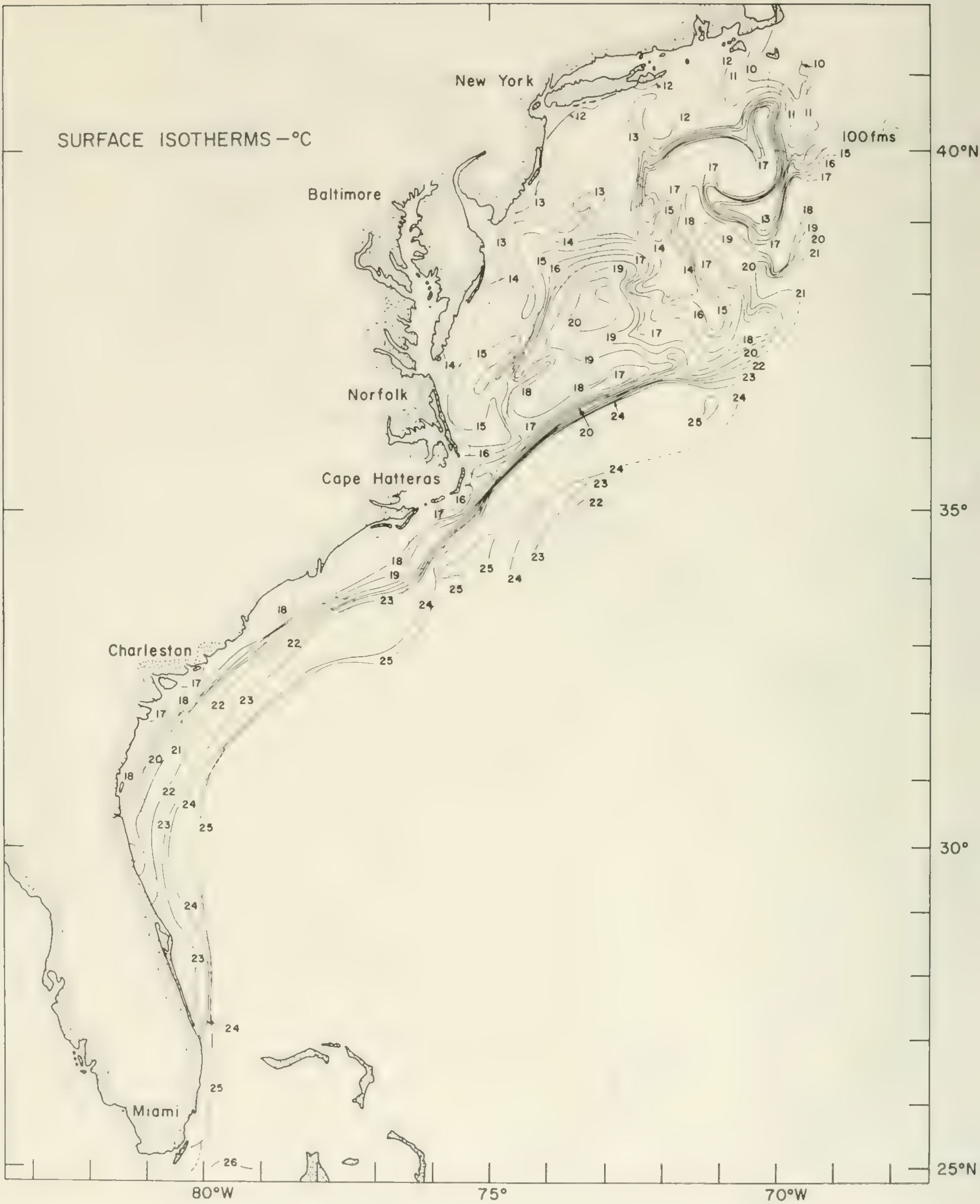

Figure 66. Monthly surface isotherm chart, 18-20 November 1975

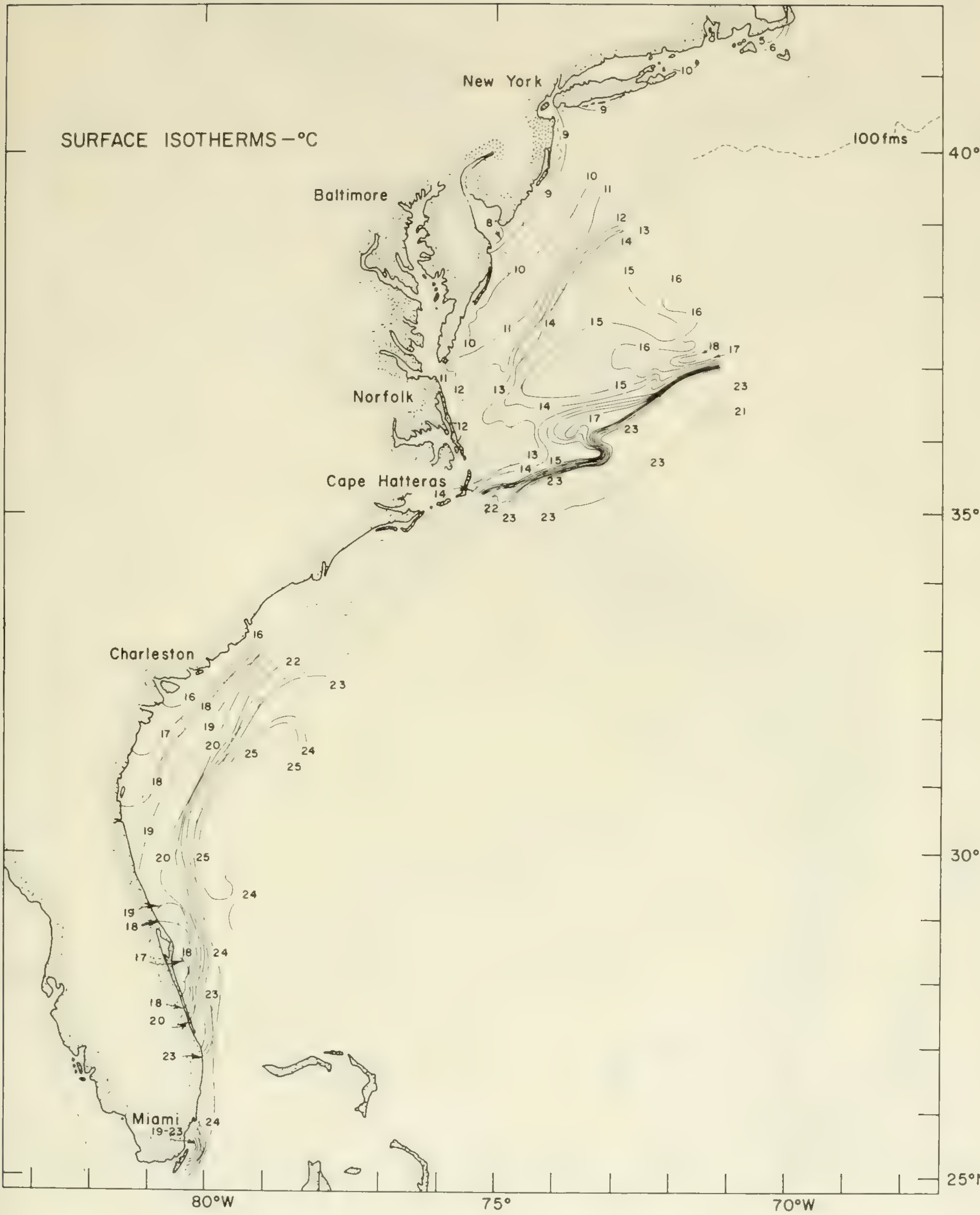

Figure 67. Monthly surface isotherm chart, 16, 17, 19, 22 December 1975

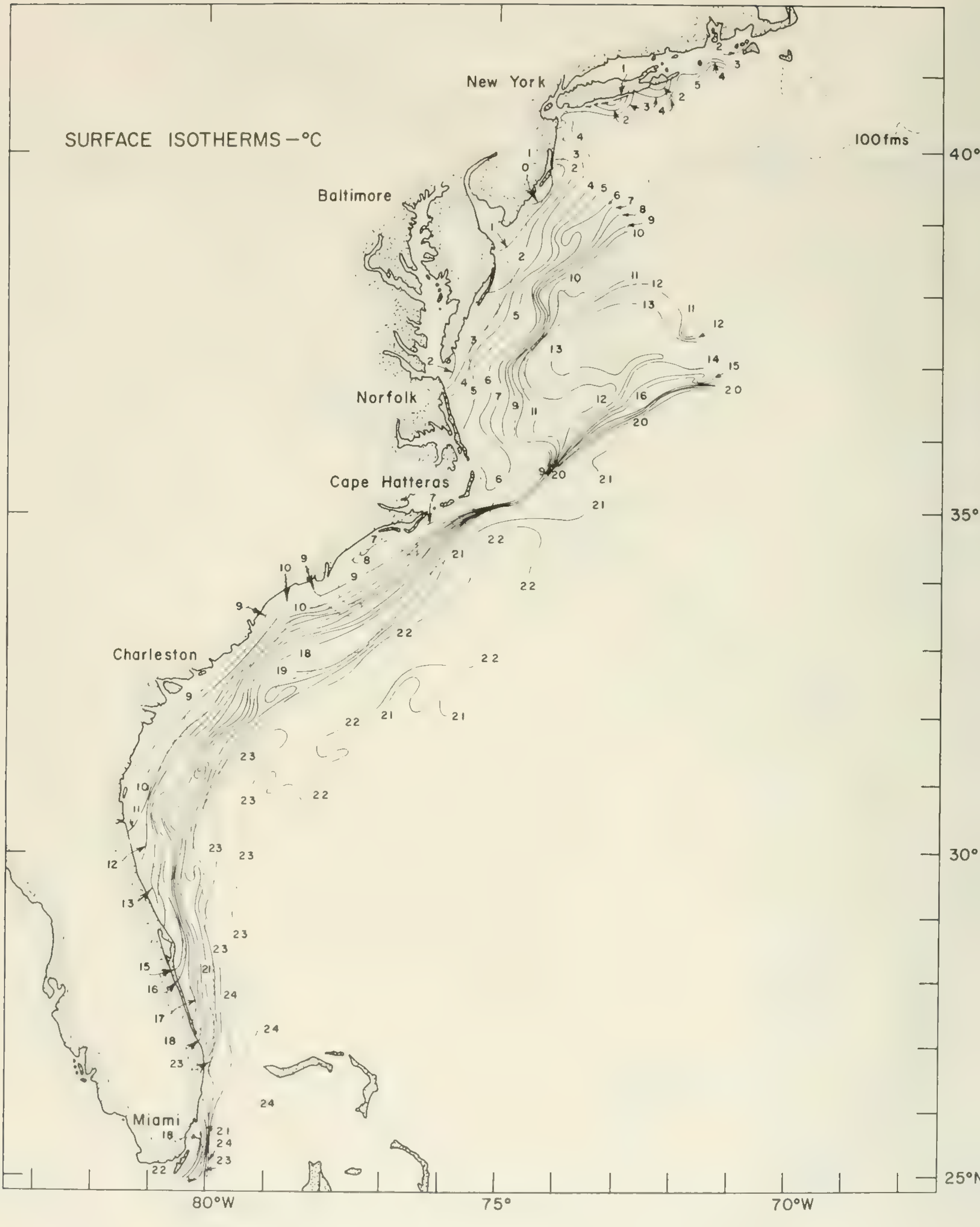

Figure 68. Monthly surface isotherm chart, 20, 21, 23, 24 January 1976

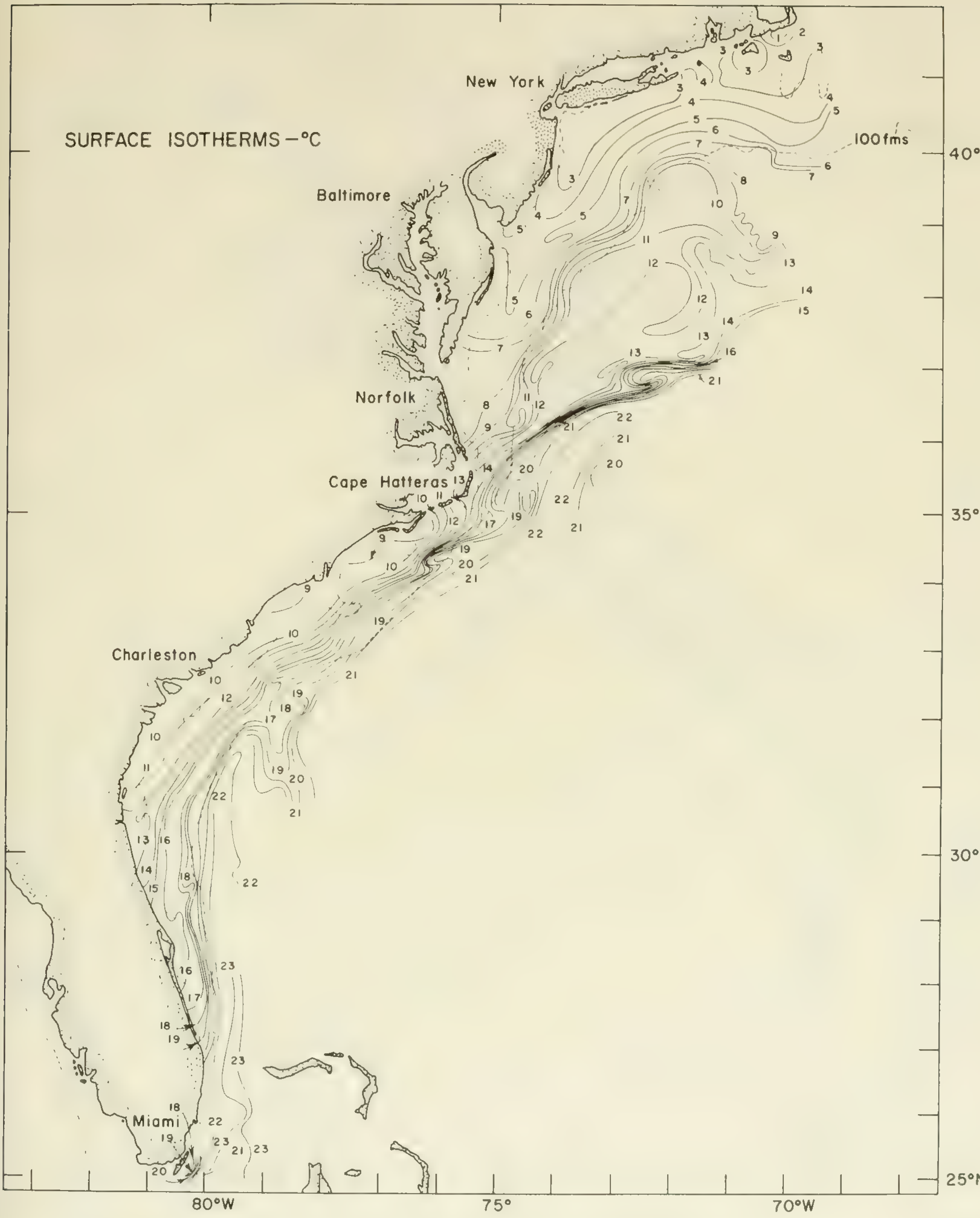

Figure 69. Monthly surface isotherm chart, 10-12, 20, 21, 23, 24 February 1976

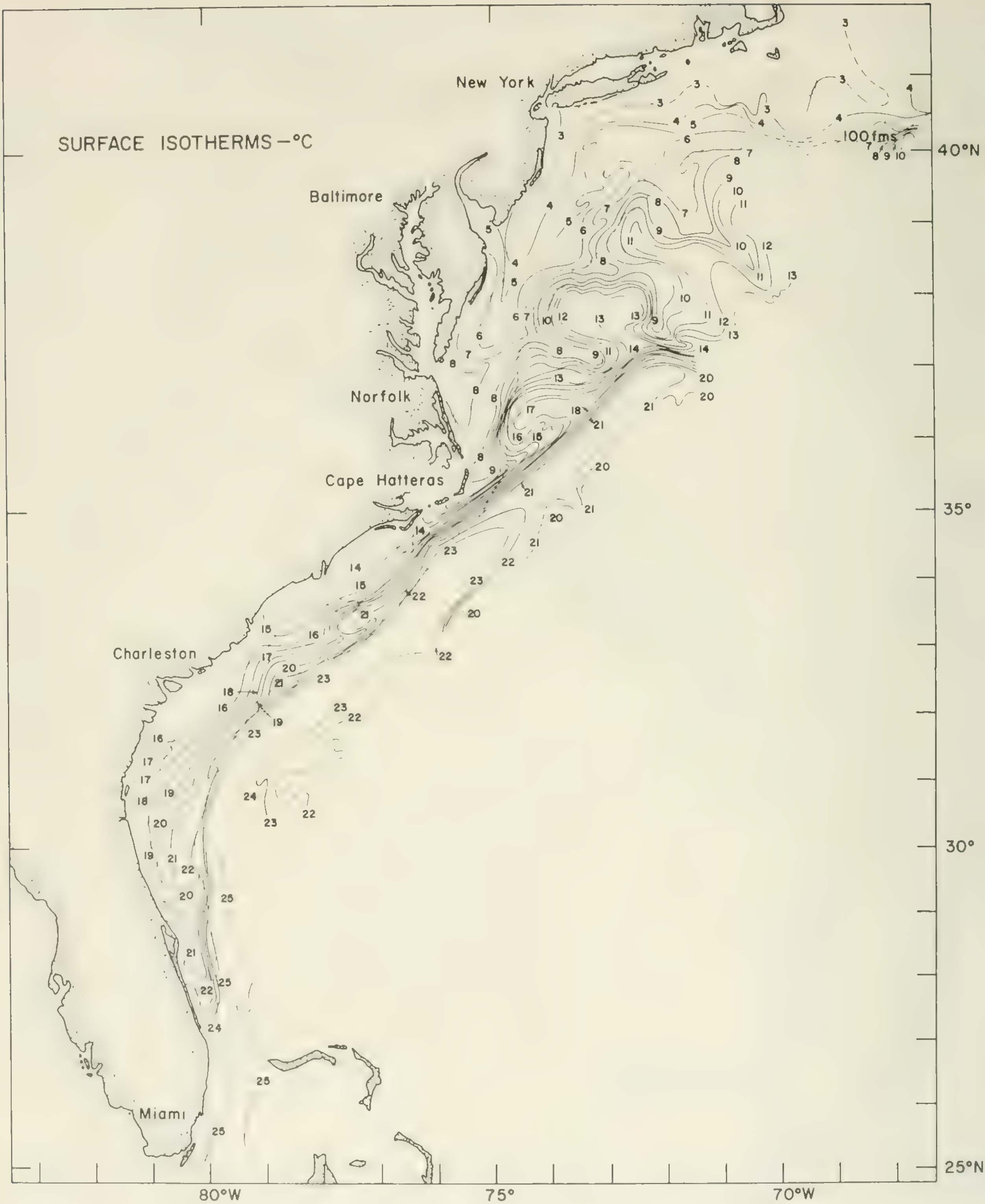

Figure 70. Monthly surface isotherm chart, 11, 12, 14, 23-25 March 1976

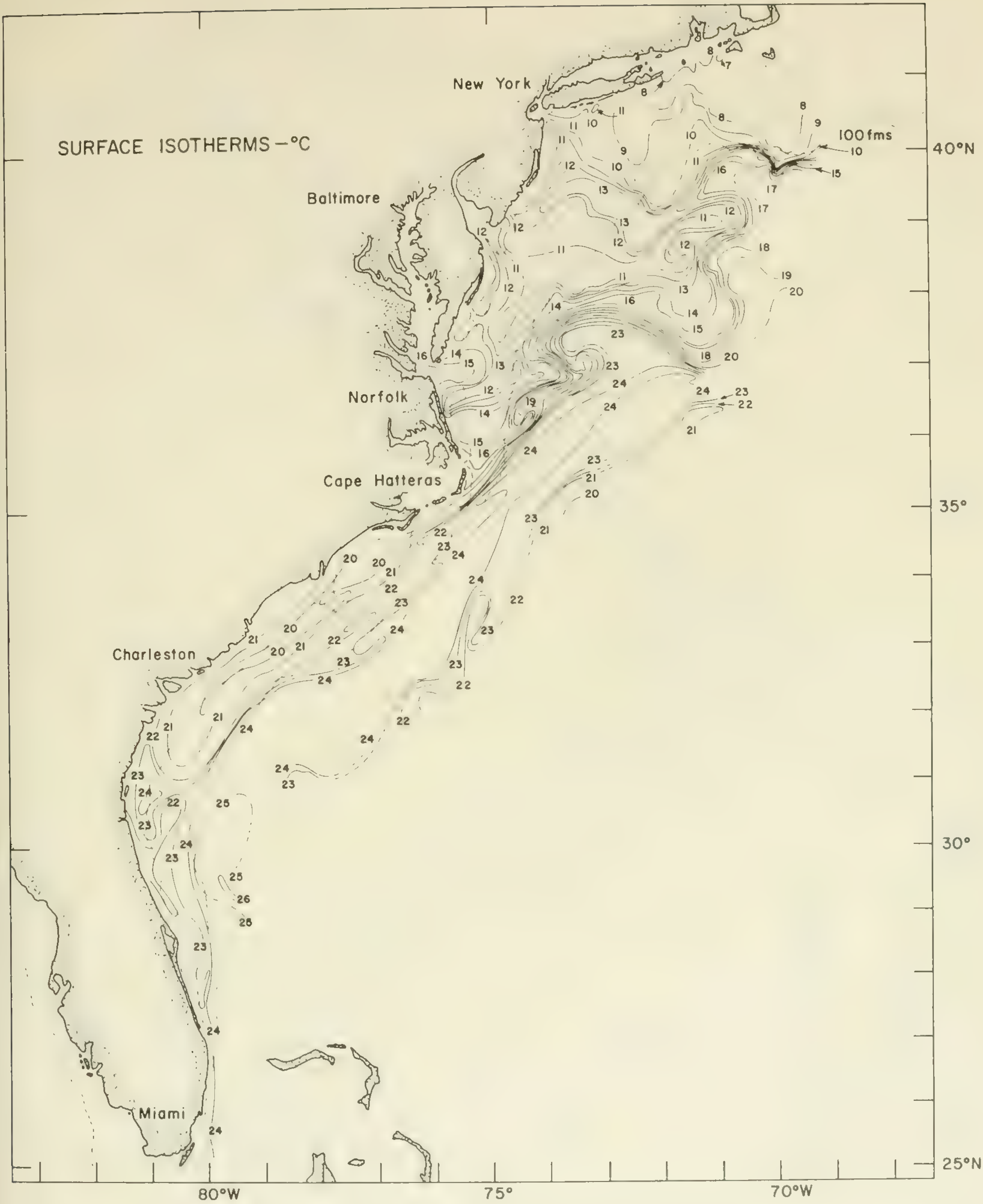

Figure 71. Monthly surface isotherm chart, 20-22 April 1976

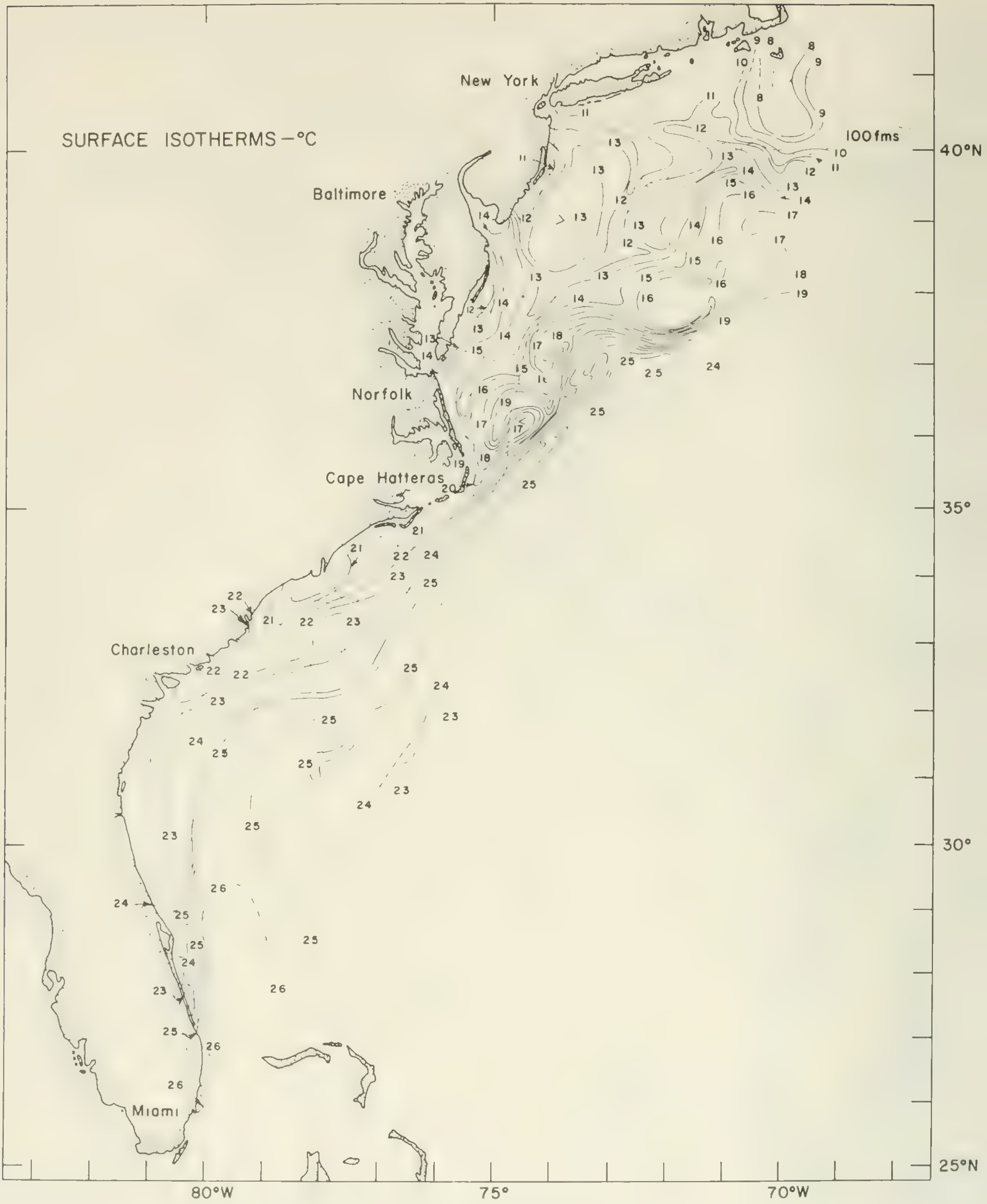

Figure 72. Monthly surface isotherm chart, 18-21 May 1976

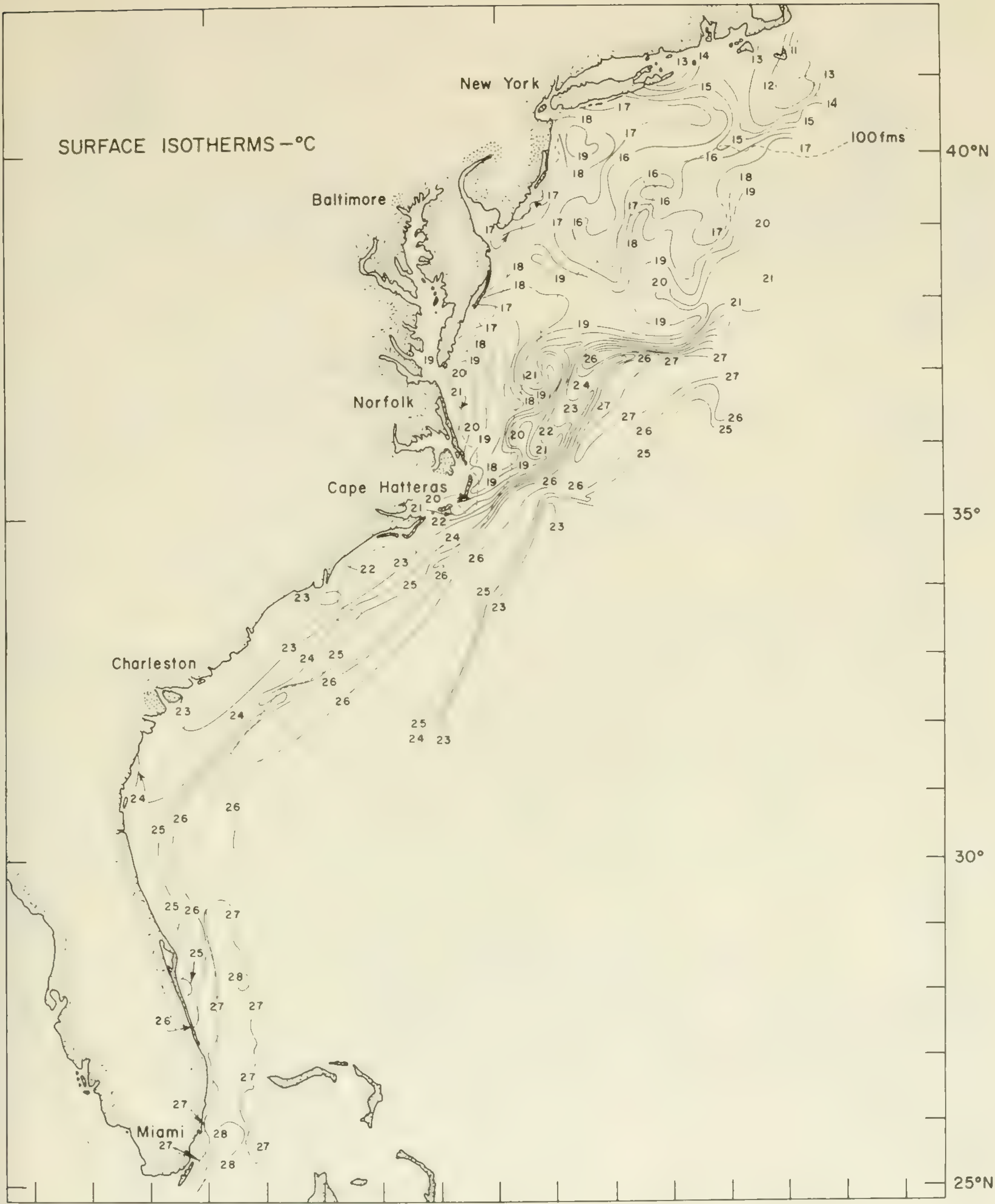

Figure 73. Monthly surface isotherm chart, 8-10 June 1976

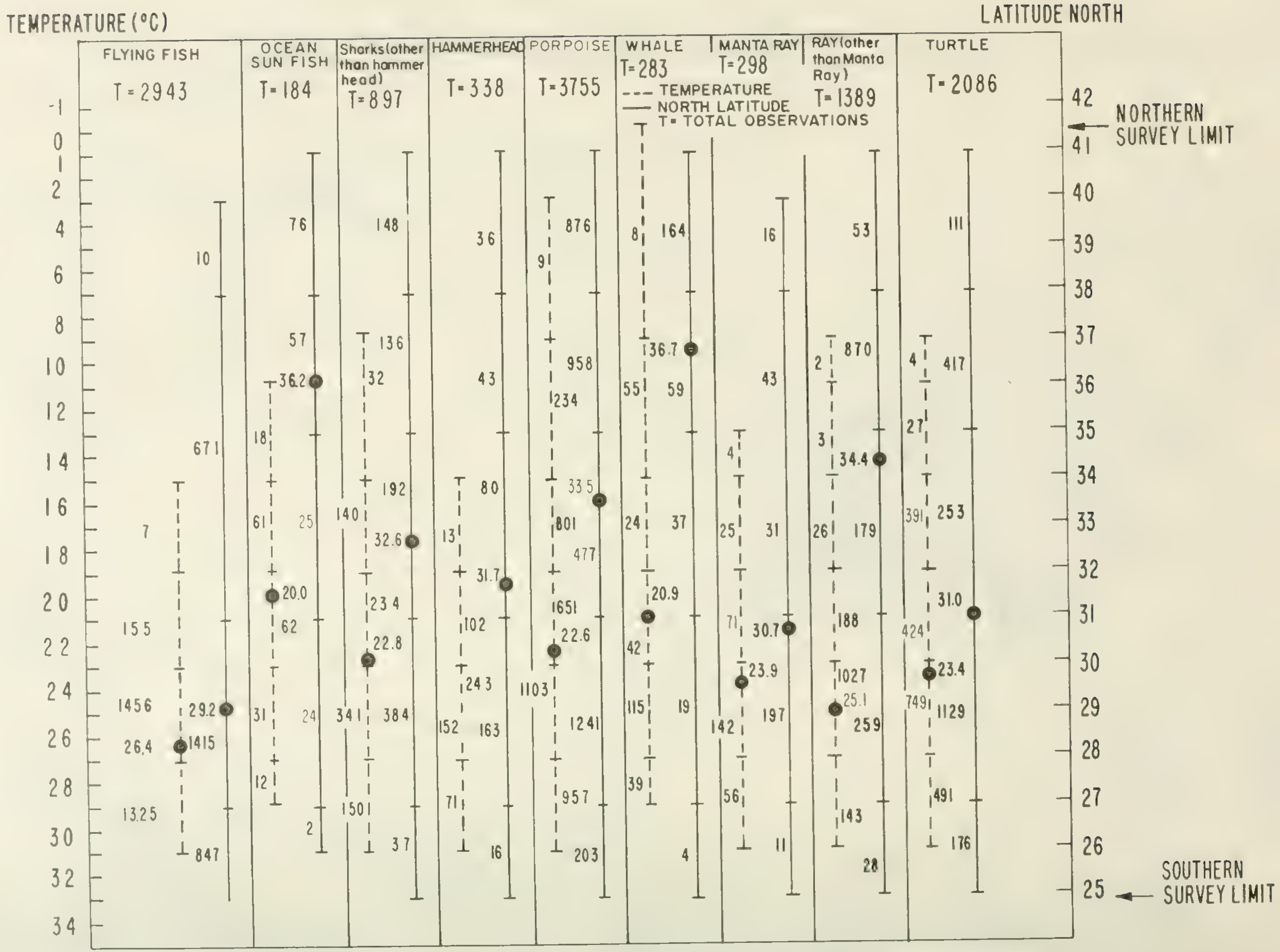

Figure 74. Graph of the plotted annual range and weighted mean temperature and latitude distribution of marine animal observations, July 1969—June 1976

Codes Utilized

A complete description of the codes utilized in the tabulation of oceanographic station data can be found in National Oceanographic Data Center publication M-2, Processing Physical and Chemical Data from Oceanographic Stations. (Rev. August 1964, supplement issued May 1966.)

To facilitate use of the oceanographic station data listing, entry headings which are not self-explanatory are described below.

REFID	NODC reference indentity number.
CONSEC	Consecutive station number.
BOTDP (B)	Uncorrected sounding depth in meters.
SHIP (B)	NODC assigned platform identity code.
DATA USE	Entry 1 identifies DNP data.
AREA	NODC ocean area code.
CLOUD T/A (B)	Cloud type according to WMO code 0500 and cloud amount according to WMO code 2700.
Wave observations	
DIR	Direction from which dominant waves are coming in tens of degrees according to WMO code 0885.
HGT	Height of dominant waves according to WMO code 1555.
PER	Period of dominant waves according to WMO code 3155.
SEA (B)	Sea state according to WMO code 3700.
CL/TR (B)	Water color according to forel-Ule code. Transparency in meters as determined by Secchi disc.
WIND DIR (B)	Direction from which wind is blowing in tens of degrees according to WMO code 0877.
WIND SPD (B)	Wind speed in knots.
WIND FOR (B)	Wind force in beaufort code.
WEATHER (B)	Weather code—If preceded by letter X is according to WMO code 4501. A numeric two digit entry indicates weather according to WMO code 4677.
INST	Instrument used for observation—"Nansen Cast" indicates station consists of Nansen cast data—"STD Recorder" indicates station consists of STD data or a mixture of STD and Nansen cast data.
TRACE DIR (B)	"Trace" indicator U (UP), D (DOWN), and A (AVERAGED)—used with STD casts, and specify that data were taken while hoisting or lowering respectively or that the two traces were averaged.
DURATION (B)	Time elapsed during raising or lowering of the STD recorder to tenths of hours.
ORIG (B)	Originator's reference number in two parts—cruise number or 3 characters (if year of cruise forms part of cruise number years digits may sometimes only be found in "Year" field), and station number.
TEN SQ	Ten-degree square—modified Canadian square number.
5 SQUARE	Five-degree squares—modified Canadian system.
2 SQUARE	Two-degree squares—modified Canadian system.
1 SQUARE	One-degree squares—modified Canadian system.
CASTNUM (B)	Number of cast on multicast stations (blank when messenger time is given).
TIME (B)	Time of release of messenger in hour and tenths for applicable observed levels. If multicast series extends past midnight, 24 hours are added to cast time of next day. Beginning time for STD is given at first obs depth.
LVLTYP	Type of record at depth indicated. "OBS"—observed values. For STD recorder = level of data read-out. "STD"—NODC standard interpolated values. "ORG"—Standard or other depths carrying non-NODC interpolated values. "LIT"—Interpolated standard depth values used as obs for computational purposes. Note—When an observed level coincides with a STD depth level, both "STD" and "OBS" lines will appear.
DEPTH	Depth of sample (or standard level) in whole meters. Prefix "T" indicates thermometrically determined depth (depth of unprotected thermometers). Subscript "Q" indicates that the value is marked doubtful by the originator. A value designated as implausible by NODC is marked with a "P". Postscript "Z" indicates uncorrected and inaccurate 'Wire-out' depths (high wire angle present).
TEMP (B)	Temperature in degrees celsius. For 'Q' and 'P' notation see depth field.
SAL (B)	Salinity in parts per thousand. For 'Q' and 'P' notation see depth field.
SIGMA-T (B)	Seawater density anomaly to 2 decimal places. When depth, temp, or salinity is doubtful, a 'Q' is suffixed. An asterisk indicates a decrease of 0.02 or more from the previous level.
DYNDPTH	Dynamic depth anomaly in dynamic meters to millimeters.
SND VEL (B)	Sound velocity in meters per second to decimeters according to Wilson's formula. (A standard depth-pressure term is used for stations not beginning at the surface).
OXYG (B)	Oxygen in ML/L to hundredths.